ARMY ORDNANCE

VOL. XXIII, No. 133 JULY-AUGUST, 1942

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Bomb Defense
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"Enough and On Time"
A Tribute

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Toward Victory
A Résumé

A REVIEW OF INDUSTRIAL PREPAREDNESS FOR NATIONAL DEFENSE
PUBLISHED BY THE ARMY ORDNANCE ASSOCIATION, WASHINGTON, D. C.

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ARMY ORDNANCE

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THE ARMY ORDNANCE ASSOCIATION

The Aims, Purposes, and National Officers of the Society

THE Army Ordnance Association, a national society of more than 10,000 American citizens, was founded in 1919, "pledged to industrial preparedness for war as our nation's strongest guaranty of peace." The society was incorporated under the laws of the District of Columbia in 1928. Its entire energies are now dedicated to victory for the armed forces of the United States. For the duration of the war it is "pledged to victory—complete, absolute, final."

The Association has endeavored during the past twenty-two years to keep alive an interest in and knowledge of the design, production, and maintenance of military armament. This it has done through periods of public lassitude and times of great national emergency. Until 1940 there was no peace-time armament industry in the United States for the production of ordnance. Now all American industry is being geared rapidly for victorious war production.

The principal objective of the society is an active membership of American citizens to assist in the design, development, procurement, production, maintenance, and supply functions of the Ordnance Department of the United States Army. When peace returns this body of informed citizens will again continue to be a bulwark of knowledge, experience, and ability upon whom the Armed Forces of the United States can rely for technical and scientific assistance and for industrial preparedness.

The Association is devoted solely to the national defense; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its elected officers and directors serve without remuneration. Membership, to which American male citizens are eligible, is four dollars a year. (Application on request.) There are eighteen local chapters of the Association throughout the United States.

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guaranties of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect coöperation with American scientists, inventors, engineers and manufacturers in civil life and the Regular and Reserve officers of the Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the industry of the nation and by the officers and civilian employees of the Ordnance Department in the wars in which the United States has been engaged.

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ARMS AND THE WAR

PHASE II

THE supply of weapons to the armed forces of the United States and the United Nations has now reached its second phase. Logistics now becomes the dominant note of armament for victory. The years of constant toil toward mass production and quantity supply of every conceivable type of fighting machine have produced their tremendous results—American arms production is now in high gear, thanks to the sound and realistic work of the Ordnance Department of the Army of the United States, especially during the past four years.

What has been accomplished is miraculous. American industry, as was foretold in these pages during the past two decades, geared itself for battle in a minimum of time and with a maximum of effectiveness. Every private manufacturing plant in the country is directly or indirectly participating in the effort. The arsenals of the Ordnance Department have blazed the trail and are today models of arms-producing efficiency. The Ordnance district system of decentralized operation has proved its value beyond question. Every officer and soldier, every executive and artisan, can take pride in the achievement.

What remains to be done will require equally herculean strength. Research must go on apace so that new and secret weapons are supplied quickly. Arms production must continue not only at its present tempo but at greatly accelerated speed. Transport and maintenance of our vast arms stores daily become more pressing problems. The logistics of armament supply—the integration of all forces so that the soldier at the moment of combat has every weapon that he needs for victory—is the second phase of our effort.

Maj. Gen. Levin H. Campbell, Jr., has been chosen as Chief of Ordnance of the Army. It will be his duty to effect this transition. He is an officer of outstanding ability and great experience. His writings in these pages through the years and his effective work in transforming industry to arms production are well known to the entire Ordnance fraternity. Ordnance logistics under his direction will meet every responsibility in full measure and ahead of schedule. He has the united support and unstinted coöperation of the Army Ordnance Association, 12,000 strong.

America is at war, the deadliest and most devastating war in all history. Victory, now as of yore, depends upon arms and the men. We will soon have, both in quantity and quality, sufficient to defeat every enemy wherever found. In so doing, Ordnance logistics under its new leadership will speed the day.

ARMY ORDNANCE

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Ordnance at War

The Correlation of Military and Civilian Defense

Henry A. Wallace*

THESE are days of action and planning for action. Words, whether spoken or written, are of little use unless they lead to action. Men and women, young and old, all feel this way. Pearl Harbor and Bataan have doubled the intensity of their feelings. But feelings, like words, are no good in times like these unless they lead to action. You who are graduating today have already proved yourselves to be men of initiative and action. . . .

I have learned something about you during recent months because from time to time on Sundays my son Bob has brought some of you to spend a few hours with us in our home. I know you come from every walk of life and that the only qualities which count are intelligence, integrity, leadership, and drive. During the past thirteen weeks you have devoted these qualities to finding out all you can about tanks, scout cars, artillery, antiaircraft, and the munitions which serve these different weapons. This is the first completely mechanized war in history, and it is up to you men in Ordnance to see that the machines are kept going.

More than any other nation we understand machinery, and the moment our factories begin really to roll I have no fear about the final outcome. By the last half of this year we shall be producing more war matériel than any nation in the history of the world. I know something about this because in recent months I have been sitting with the Secretary of War and the Secretary of the Navy on the War Production Board, and we have all watched and encouraged Don Nelson in his efforts to get our industry diverted from automobiles to the production of machinery which really counts in the line of battle. You as Ordnance officers can help us in our civilian job. If you can repair a gun or a tank in the field and send it right back to service, each hour of your effort in the field will save us hundreds of hours of effort here in the United States.

You have worked hard during the past three months, but your work has just begun. Any one who works hard finds that by so doing he merely earns the privilege to engage in still more difficult work. It is something like the statement of the famous French philosopher, Pascal, who said that when he knew a little, his small body of knowledge might be represented by a little circle touching the unknown, but when he knew more, his knowledge might be represented by a large circle touching the unknown. In other words, the man who knows little has the feeling that there is little left for him to know. The man who knows a lot recognizes, as he looks out from the large circumference of his knowledge, what an infinity there is yet to be known. . . .

It is amazing what the human spirit and will can do when turned enthusiastically in one particular direction. A Joe Louis or a Don Budge demonstrates this to us in the field of sports. They are literally a hundred times as good as the ordinary person. The German, Japanese, and Russian armies, and the British Royal Air Force have given us remarkable demonstrations in the military world. We in the United States have proved our outstanding excellence in industrial production. In the military world we have not heretofore cared to excel, because we didn't feel that human progress lay in that direction. But now, because we have to, we will do the job. During the remainder of this year, nearly half the national effort will be given to war. From a small rivulet, our war materials are now swelling to a mighty river. The vast flood of material will be placed on the line of battle under the direction of men like yourselves.

THE civilian population will deny itself, whether in the factory or field, in order that you men may have the material on the spot where it will do the most good. Every disaster which comes to us during the hard months immediately ahead will only increase our enthusiasm and our will to do the job. Americans are not quitters. You men are not quitters. Not recognizing what was going on in the world, we hated to turn our attention away from thoughts of peace to military matters. Now that we have to fight, we are going to fight with enthusiasm, doing the job more whole-heartedly than either the Germans or the Japs. . . .

We hate the dark philosophy which has taken possession more and more of the German and Japanese souls during the past one hundred years. We are out to destroy that philosophy, root and branch, so that it may never rise again. To do that job well we must build up a decent philosophy of our own. This is a freedom war and no one in the United States is going to compel any one else to believe in any particular philosophy, but gradually, as the war develops, the blackness which is Germany and Japan will awaken in us a universal feeling of just what it is we are fighting for. That will be the great blessing which will come out of this war. The faith of our fathers, based on the freedom and dignity of the individual human soul, will begin to glow in a brightness which it has never had before. Life will take on increasing depth of meaning as a result of the sacrifices which we have been forced to make. We are on the verge of a new era, and you men who this day are receiving your commissions as second lieutenants will have the privilege of being not merely second lieutenants in this all-important fight for freedom, but you will also have the opportunity, I trust, to be, figuratively speaking, captains in the peace effort which will challenge the best that is in all of us when the war ends.

*Vice-President of the United States.
This is an address delivered at the graduation exercises of the Officer Candidate School, Army Ordnance Training Center, Aberdeen, Md.

Bomb Defense

Some Engineering Aspects of Protective Construction

Col. A. M. Prentiss*

THERE is probably no invention in modern times which has already effected, and is further destined to bring about, such far-reaching changes in our civilization of today as the airplane as an instrument of warfare. Air power already has caused a complete reorientation in the art of war and, indeed, in the very objectives of military strategy itself. And this is only the beginning of the foreseeable effects of air warfare on modern life. More and more will large cities and industrial centers become the principal objects of military attacks from the air which will necessitate radical changes in the planning and building of these cities in the future.

The first step will be to remove essential industrial plants and vital public-service utilities from the cities and to disperse them at safe distances in the rural areas outside the communities they serve. The net result of this process will be to reverse the trend toward the building up of large urban communities started in the nineteenth century by the Industrial Revolution. The tremendous development of motor transportation during the past three decades already has made the congestion of population in large cities unnecessary, and it is now no longer essential to locate factories in cities in order to be near the labor market—this despite the temporary tire shortage. With the imperative necessity of removing large industries from the great cities, brought about by the danger of air attack to the whole surrounding population, we may expect to see an increasing trend toward decentralization of industries to rural areas and small communities.

The armament of the modern bombardment airplane comprises high-explosive and incendiary bombs, machine guns, and light cannon. To these may be added gas bombs and chemical sprays which also have been developed for use by aircraft in Europe and the Far East. However, since aircraft machine guns and cannon are not normally used against nonmilitary ground targets, civil air defense is not seriously concerned with the protection of the civilian population against these weapons.

Two kinds of aërial bombs are in general use today: high-explosive and incendiary. To these may be added gas bombs which have been developed but have not been employed in Europe to date; there are, however, apparently well-authenticated reports of the use of gas bombs by the Japanese against the Chinese. The purpose of the high-explosive bomb is to destroy property and life by its tremendous shattering effect and the striking power of its fragments. The object of the incendiary bomb is to start numerous fires simultaneously over an extensive area, such as the built-up sections of large cities, while gas bombs may be used to release toxic gas in occupied areas.

High-explosive bombs are of three principal types: demolition, general-purpose, and fragmentation. Demolition bombs are primarily designed for destroying unprotected targets of usual design and unfortified installations. Destructive effects are obtained by the intense blast resulting from the explosion of these bombs. They are generally classed as medium- or light-case bombs and vary in weight from 100 to 4,000 pounds.

The general-purpose bomb is a medium-case bomb of intermediate weight (20 to 1,000 kilograms), and is usually equipped with a delayed-action fuze. Such bombs will penetrate the roof and upper floors of ordinary buildings before exploding and thus cause considerable damage inside. They may also demolish unprotected buildings by their blast effect if they explode close to the building on the ground outside.

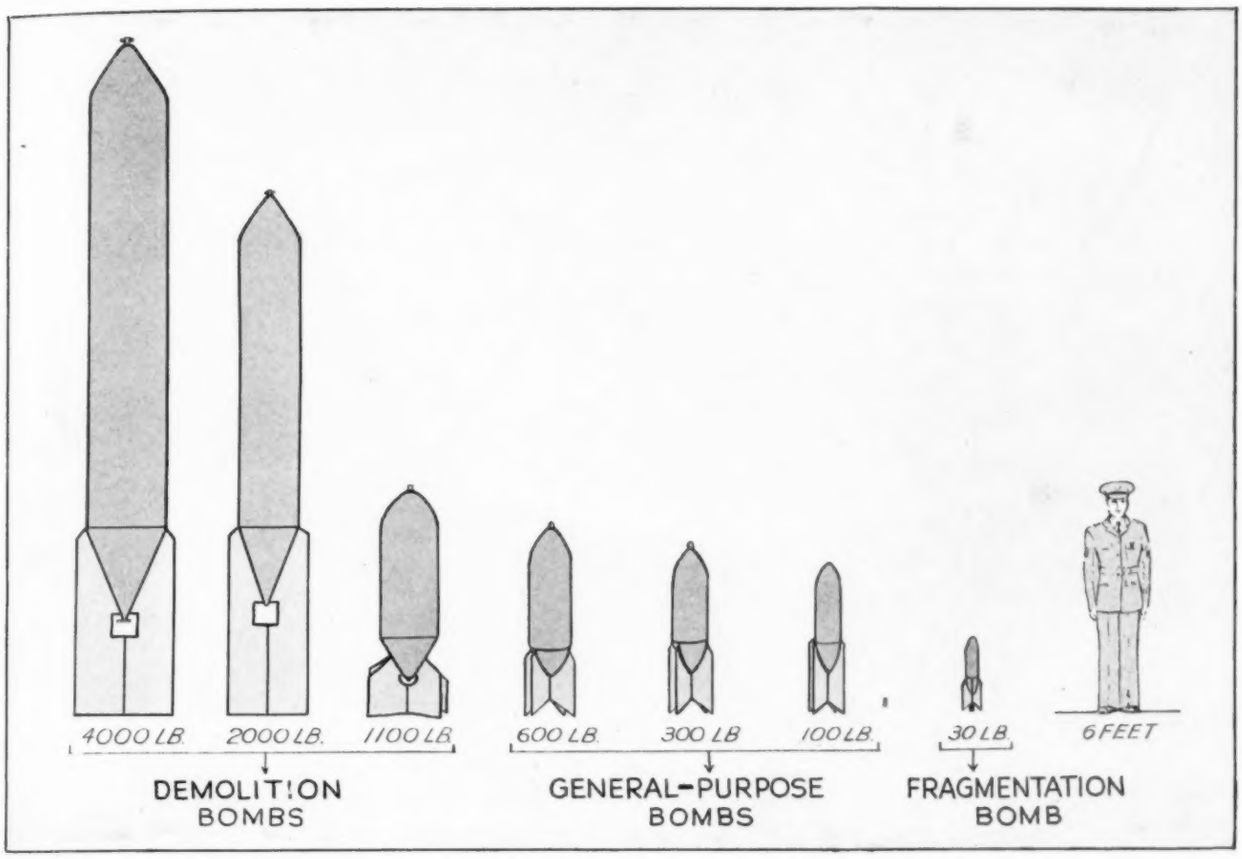
Fragmentation bombs are small bombs, usually varying in weight from 10 kilograms (22 pounds) to 25 kilograms (55 pounds) and are designed primarily to kill or wound persons in open areas by the striking power of their fragments.

The destructive power of the high-explosive bomb is the resultant of its several effects which are produced in approximately the following sequence: (1) impact, (2) penetration, (3) blast, (4) fragmentation, (5) cratering, and (6) rupture or mining effect. Although these are distinguished for purposes of study and evaluation, it must be borne in mind that they occur almost simultaneously, and their effects cannot be negatived selectively.

WHEN a bomb strikes a building, its first effect is to produce a sudden load on the structure, owing to the retardation of the bomb by the walls and framework. Thus, if a 660-pound bomb strikes a structure with an impact velocity of 1,000 feet a second and is brought to rest after it has penetrated a distance of one foot, it will impart to the structure an impact load of approximately 10,000,000 pounds. In the case of an articulated structure, such as a steel-frame or reenforced-concrete building, the impact effects are mainly local, being absorbed by the deformation of the bomb case, generation of heat, and pulverization of the material struck. The portion of the impact load that is transmitted by a slab to its supporting members after being struck by a bomb is small and may be neglected in the design. The distribution of this impact load is assumed by some authorities as spread over a cone of ninety degrees at the apex.

Damage wrought by a high-explosive bomb depends to a considerable degree upon the depth to which it penetrates the target before explosion occurs. This is not only because the effects of impact and explosion are thus combined, but more particularly because the explosion is more confined by the penetration and hence causes a greater disruptive effect. The greater part of the destructive effect of a high-explosive bomb, however, is derived from its so-called "blast," which is produced in the form of a shock wave by the impact of the escaping gases of explosion upon the surrounding atmosphere. The shock wave generated by the blast from a bomb exploding in the open air consists of an initial positive pressure, followed by a negative pressure of much less intensity but longer duration. The total duration of the combined positive and negative phases of a blast is about .030 seconds, of which the former is approximately .005 seconds and the latter .025 seconds. The shock wave is propagated outward

*Author: "Civil Air Defense," 1941. Coauthor (with Col. George J. B. Fisher, C.W.S.): "Chemicals in War," 1937. Chemical Officer, Sixth Corps Area, Chicago, Ill. Colonel, Chemical Warfare Service, U. S. Army.



COMPARATIVE SIZES OF VARIOUS TYPES OF HIGH-EXPLOSIVE BOMBS

with an initial velocity of about 7,000 feet a second but decreases rapidly in amplitude and velocity and eventually becomes stable at the velocity of sound—about 1,087 feet a second.

Blast pressure is thought, by some authorities, to be inversely proportional approximately as the cube and then as the square of the distance from the center of explosion, although this has not been substantiated by tests. When a bomb explodes, the outward movement of the surrounding gases probably does not exceed about twenty-five feet where the burst occurs on a flat surface in the open air, although the shock wave is propagated through the surrounding air to a much greater distance, depending upon the size of the explosive charge.

A PART of the destructive effect of the high-explosive bomb is also caused by its fragments. When such a bomb bursts, its case is shattered into a large number of splinters which are projected from the center of explosion with velocities ranging from 4,000 to 7,000 feet a second. A 30-pound fragmentation bomb yields about 1,400 fragments averaging .27 ounces, while larger demolition bombs yield from 2,000 to 6,000 fragments, the bulk of which will be less than one ounce. When a bomb explodes above ground in the open, the extreme range of the fragments will vary from about 100 yards to nearly a mile, depending upon the size and type of bomb and its density of loading. If a bomb penetrates a solid target before bursting, the projection of fragments will be reduced in proportion to the depth of penetration.

Another effect of an exploding high-explosive bomb is the formation of a crater. The size of the crater depends upon the depth of the bomb penetration, the size and character of its explosive charge, the nature of the medium penetrated, and the energy required to burst the bomb case. The amount of earth displaced in the formation of bomb craters varies from approximately 50 cubic yards for a 100-pound bomb to about 1,000 cubic yards for a 4,000-pound bomb.

In addition to the damage caused by the formation of a crater, a bomb exploding within a solid medium transmits pressure waves through the medium, accompanied by a displacement of the medium surrounding the crater. These pressure waves and the physical displacement of earth are similar to those produced by mines, and the phenomena are known as "mining effect." The mining effect of high-explosive bombs exploding below the surface of the earth is an important factor in the destruction of buildings by undermining their foundations and in damaging underground utilities such as water and gas mains and electric, power, and telephone cables. The distance to which a high-explosive bomb bursting underground will exert its mining effect is measured by its horizontal radius and depth of destruction. Fortunately, these distances for even the larger demolition bombs are very limited, so that accurate placement of such bombs is necessary and the resulting damage is highly localized.

In order to ascertain the effects produced on underground structures, such as air-raid shelters, by bombs bursting underground in the near vicinity thereof, formulas based on mine warfare have been developed for determining the shortest distance to which damage does not occur to a timbered structure from the ordinary land mine in the same horizontal

plane. This distance is called the "maximum horizontal radius of rupture" and may be taken as the minimum lateral protection that must be provided to insure the integrity of underground structures from bombs exploding underground in the near vicinity.

There is but one practicable method of protection against high-explosive bombs, and that is to interpose between the point of explosion of the bomb and the object to be protected a resisting medium of sufficient strength to wholly or partly neutralize the destructive effects of the bomb. Such resisting mediums are commonly called air-raid shelters, and the problem of protection against high-explosive bombs is, therefore, essentially a problem of the location, design and construction of such shelters.

The protection afforded by a shelter is not absolute but is one of degree, depending principally upon the size and nature of the bombs involved and the distance through which they fall after release from the airplane. Complete protection is afforded only by a shelter that is capable of withstanding the largest-sized bomb when dropped from an altitude affording maximum striking velocity. Only such a shelter is truly "bombproof," but it is seldom justified in actual use, because of the great expense involved in its construction.

IN dealing with the problem of protection against high-explosive bombs it must be accepted at the outset that universal provision of complete immunity from danger is impossible of practical attainment. The objective to be sought is, therefore, a balanced program of reasonable protection, considering that in war the factor of time is of vital importance and that it is necessary to avoid an excessive diversion of the national effort from other activities essential to the prosecution of the war. In principle, the protection to be furnished any particular community or establishment should bear relation to its liability to air attack, its vulnerability to such attack, and its value to the nation's war effort.

Since it is usually impracticable to provide effective protection against direct hits of the large-sized bombs, it is necessary to formulate a general policy as to the degree of protection that will normally be furnished to personnel and vital establishments. The following policy of the British Goverment may be regarded as a reasonable solution of this complex problem:

In general, protection should be provided against blast and fragments from a 500-pound bomb bursting 50 feet away and against falling parts of antiaircraft shells. In special cases, partial protection may be accepted initially (in the case of buildings, protection up to window-sill level and, in the case of trenches, the omission of overhead cover). Since the casualty-producing possibilities of a direct hit must be limited by dispersion, protection should be afforded on the principle that fifty persons at the most can be affected by a single bomb. This number should be reduced if possible.

As regards the protection of persons against high-explosive bombs, the various types of shelter employed in Europe may be classified roughly in the order of relative protective value as follows: (1) Deep tunnels and galleries, where the overhead cover is sufficient to resist the combined effects of penetration and explosion of heavy demolition bombs; (2) Deep dugout shelters, vaults, and strong rooms; (3) Subways and commercial tunnels (provided sufficient overhead covering is obtained); (4) Multistory framed buildings; (5) Outdoor shelters; (6) Indoor shelters (to include cellars and refuge rooms in ordinary houses); (7) Outdoor barricades.

Passing now to a consideration of the problem of protection against incendiary bombs, we observe that the purpose of these bombs is to start a large number of fires simultaneously over the target area. Incendiary bombs are, therefore, generally of minimum size so that the maximum number can be carried within the load capacity of a bombing plane. Thus, an average bomber can carry a thousand 1-kilogram (2.2-pound) incendiary bombs which may readily start at least 100 fires over a closely built-up area approximately 100 yards wide by 5,000 yards long.

It cannot be too strongly emphasized that the chief danger from air attack with incendiary bombs is the probability of a large number of fires occurring at the same time over a considerable area. Unless these fires are extinguished promptly, they will almost certainly give rise to widespread conflagrations which may produce enormous property damage and seriously dislocate the normal life of the community.

THE prevailing type of small incendiary bomb used in Europe during the past few years is the 1-kilogram thermite-magnesium bomb. When dropped from a height of 5,000 feet, this bomb penetrates any ordinary roof (including tiles, slate, and corrugated iron) and an underlying plaster ceiling, but probably not a wooden floor below. It is, therefore, apt to remain in an upper story and start a fire, either in the garret or on the first floor below the roof. Moreover, if the burning bomb is not promptly extinguished or removed, it may burn through a wooden floor and possibly through one or more floors below, thus causing a succession of fires.

When the thermite-magnesium bomb strikes an object, the thermite filling is ignited and burns fiercely at a temperature of about 3,000° C. for approximately 1 minute, melting and setting fire to the magnesium casing, which, in turn, burns less fiercely than the thermite for about 15 minutes. While the thermite is burning, the combustion reaction is very violent, jets of flame are emitted from the ventholes of the bomb, and pieces of molten magnesium are often thrown as far as fifty feet. Since thermite contains its own oxygen, it cannot be extinguished by smothering, but the magnesium must receive oxygen from the air or surrounding materials in order to burn. Except for a few ounces of sheet iron in the tail and igniter, the whole of the thermite bomb is consumed in the reaction of combustion which makes this type of bomb of high efficiency.

Incendiary bombs produce a very intense heat. Thermite types, such as that just described, cannot be extinguished with water; on the contrary, the application of a jet of water directly to the burning bomb is dangerous, for it may cause the bomb to explode and project molten masses of white-hot metal for a distance of fifteen to twenty yards. Though smothering with sand is one of the most effective ways of controlling a burning thermite-magnesium bomb, it may not prevent fires when the bomb falls on an ordinary wooden floor or among inflammable materials. The burning action of the bomb on wooden flooring varies considerably. As a rule, ⅞-inch boards are burned through in four to five minutes, but occasionally the time is considerably longer. Once a fire has started in a building, it must be extinguished with water, soda-acid chemical fire extinguishers, and other ordinary fire-fighting appliances.

The methods and means of protection against incendiary bombs may be grouped into two distinct categories: (1) General precautions in advance of an incendiary attack to reduce fire hazards and to insure prompt detection when incendiary

Weight of bomb (pounds)	Caliber of bomb (inches)	Weight of bomb filling (pounds)	Sectional density of bomb (lbs./sq. in.)	Depth of penetration (feet)		Crater dimensions in earth (feet)		Crater dimensions in concrete (feet)		Radius of destruction in earth (feet)		Horizontal radius of rupture in earth (feet)	Horizontal radius of rupture in concrete (feet)	Danger zone from fragments (feet)
				Natural earth	Reënforced concrete	Diameter	Depth	Diameter	Depth	Horizontal	Depth			
European Bombs														
	a	*a*	*a*	*a*	*d*	*e*	*e*	*e*	*e*	*f*	*f*	*g*	*g*	*h*
110	7.1	57	2.78	13.7	1.1	27.4	3.4	3.8	0.9	11.0	23.7	25.5	12.6	200
220	9.8	120	2.92	14.4	1.3	28.8	4.8	5.2	1.3	14.0	27.4	32.9	16.3	300
660	14.2	360	4.20	20.7	1.8	41.4	6.9	10.1	2.8	20.2	38.9	47.4	23.5	400
1,100	16.6	600	5.00	24.6	2.1	49.2	8.3	13.4	3.8	23.9	46.5	56.2	27.8	600
2,200	21.6	1,200	6.00	29.5	2.6	59.0	9.8	18.2	5.2	30.2	55.2	70.9	35.1	1,200
4,000	25.6	2,200	7.80	38.0	3.3	76.0	12.7	26.4	7.7	41.8	72.8	86.7	42.9	2,400
American Bombs														
b	*b*	*b*	*b*	*c*	*c*	*b*	*b*	*e*	*e*	*f*	*f*	*g*	*g*	
100 (120)*	7.9	67	2.13	10.5	0.9	20.0	5.0	3.2	0.7	11.5	22.0	27.0	13.4	200
300 (285)*	12.2	148	2.43	12.0	1.0	27.0	7.0	4.4	1.1	15.0	25.5	35.4	17.5	300
600 (625)*	16.5	349	2.90	14.3	1.2	37.0	10.0	6.7	1.8	20.0	32.4	46.9	23.2	400
1,100 (1,130)*	20.8	632	3.32	16.3	1.4	45.0	13.0	9.0	2.5	24.4	38.4	57.2	28.3	600
2,000 (2,030)*	18.5	1,060	7.55	37.1	3.2	53.0	16.0	22.4	6.4	28.9	61.7	68.0	33.7	1,200

a From M. Bazant, "The Use of Reënforced Concrete for Fortifications and Air Raid Shelters," in *Travaux*, Nos. 52 and 53, April and May 1937, Tables 2 and 3, for impact velocity of 820 ft./sec., corresponding to a bombing altitude of 13,350 ft. at 200 m.p.h.
b From Technical Regulations 1370-G, War Department, Washington, D.C.
c Computed in accordance with formula on p. 30, "Civil Air Defense" (New York: McGraw-Hill Book Co., 1941), for impact velocity of 820 ft./sec.
d From Bazant, (*loc. cit.*), Table 2, for concrete slab supported over whole of its surface.
e Computed from depths of penetration, in accordance with formulas on p. 39, "Civil Air Defense," for "normal" bomb ($n=1.0$).
f Computed from formulas on p. 42, "Civil Air Defense".
g Computed from formula on p. 43, "Civil Air Defense".
h From "War on Great Cities," by Frank Morison (Albert Henry Ross); London: Faber & Faber.

* Actual weight of bomb.

PROPERTIES AND EFFECTS OF HIGH-EXPLOSIVE BOMBS

bombs strike a building; (2) Methods of controlling the burning bombs and dealing with resulting fires, including the organization and operation of auxiliary fire-fighting services to supplement the regular municipal fire departments.

The best precaution against fires from incendiary bombs is to make buildings as nearly as possible proof against such bombs. This can be done by interposing between the roof and the attic floor of the building a layer of ¼-inch steel plates or a slab of 4-inch reënforced concrete, supported by independent columns. This method of protection, however, is relatively expensive and seldom warranted, except for especially important builings and those housing valuable inflammable stores. In the case of buildings with roofs that can be penetrated by incendiary bombs, all unnecessary inflammable materials should be removed, particularly from attics and top floors. The floors of attics should then be covered with noninflammable material, such as (1) a 2- to 2½-inch layer of dry sand, earth, sifted ashes, or foamed slag; (2) sheets of 20-gauge corrugated iron, insulated from the floor by a thin layer of sand or earth; or (3) a ¾-inch layer of asbestos boarding, free from cement, or rock anhydrous plaster. These materials are of special value in helping to prevent the bomb from burning through the floor—thus reducing the spread of the fire. Floors of attics to be covered with noninflammable material must, of course, be strong enough to support the added load, and, where this is not the case, they must be specially reënforced and supported. Further to reduce fire risk in the attic, rafters, joists, and other woodwork should be coated with fire-resisting paint or heavy whitewash.

Since incendiary bombs can be much more effectively dealt with during their incipient stage, early information that such a bomb has fallen on a building is a valuble aid in protection. This requires good observation of the area by lookouts detailed for the purpose. Only reliable persons should be selected for this duty, and they should receive special training in making rapid and accurate reports. In their absence, reports of falling bombs should be made by air-raid wardens, police, householders, and neighbors who may observe them. Any one who observes an incendiary bomb strike a building should, of course, immediately warn the occupants and give all possible assistance in dealing with the bomb.

ALTHOUGH toxic gas has not been used to date in the current European war, and only on a small scale by the Japanese against China, World War experience demonstrated that gas has a vastly greater coverage and more far-reaching effect upon personnel than either high explosives or incendiaries and that its psychological and moral effects are even greater than its actual physiological effects. Protection against gas is, therefore, primarily a matter of public education in the characteristics and effects of war gases and the taking of requisite action in time to be effective. The next most important measures of protection against gas are adequate individual and collective antigas equipment, suitable arrangements for cleansing and reclothing personnel contaminated by persistent vesicant agents, such as mustard gas, and means for the rapid decontamination of gas-infected areas, buildings, and materials.

The first line of defense against gas is *individual* protection, involving the use of personal antigas equipment, such as gas masks and protective clothing. The second line of defense is *collective* protection, which comprises the use of gasproof and splinterproof shelters and accessory appliances.

As regards the protection of the civil population against gas attack from the air, the performance requirements of gas masks differ in degree, depending principally upon the status of the individual, respecting his function in the community.

If the individual has no duties to perform during an air gas attack or his duties are such that he can temporarily suspend them and seek shelter during such an attack, he requires only the minimum of mask protection for such time as is required to reach a gas shelter. For such people, who constitute the bulk of the population in any community, the simplest and least expensive type of mask is all that is necessary. This type is generally known as the civilian gas mask.

For persons who are required to remain at their posts regardless of conditions arising from hostile action and who are expected to perform heavy duties in strong concentrations of gas, the best possible mask protection is required. Such personnel are equipped with the military-type gas mask.

Since vesicant gases, such as mustard, will penetrate any ordinary form of clothing, including leather and rubber gloves and boots, and burn the skin of the wearer, special protective clothing is necessary to protect the body against the action of such gases. Of ordinary commercial articles of apparel, it has been found that oilskin and specially treated heavy rubber garments furnish the best protection against vesicant gases.

Collective protection against gas is generally effected by the use of gas shelters which consist essentially of an enclosed space, virtually air-tight, which is supplied with pure air drawn in from the outside through a chemical filter by means of an air pump. Gas shelters are not, as a rule, constructed separately from high-explosive bomb shelters; on the contrary, the two are usually combined in the same structure by gasproofing the splinterproof shelter as an additional measure of protection. The gasproofing of splinterproof shelters consists merely in stopping up extraneous air leaks and providing the shelter with a supply of gas-free air drawn in through a chemical filter.

Gas-contaminated ground, buildings, and material in infected areas must be quickly decontaminated in order to prevent widespread injury to personnel. The principle of decontamination is simple and consists essentially in applying a gas-neutralizing agent, such as bleaching powder, to all contaminated surfaces as soon as possible after contamination.

THE vast destruction wrought by the high-explosive and incendiary bombs employed in the current European war has only dimly foreshadowed the ultimate capacity of air bombardment to destroy life and property. To adequately deal with this menace, our defense establishments and large cities and our whole industrial and transportation systems must undergo radical change; in fact, almost every phase of modern life will be affected to a greater or lesser degree by the ever-increasing power of air bombardment. Thus, the necessity for bombproofing, fireproofing, and gasproofing in varying degree all important buildings and utilities from the city hall to the humblest home is apparent, although the extent of these measures will probably be governed by the balance between active and passive defense, in addition to other considerations.

The shock effect of high-explosive bombs produces a far greater strain upon the elements of a structure surrounding the point of impact than the most severe live loads with which engineers have been familiar in the past. Accordingly, formulas involving stresses and strains, which constitute the foundation of engineering design, must undergo revision to take these new factors into account. However, the shock effects of high-explosive bombs do not produce critical strain upon *all* the elements of the structure, as these effects are confined principally to the surface struck. After protective thicknesses are provided, with minimum percentages of steel to protect against scabbing, the usual design methods may be used in checking stresses due to dead loads. Special attention must be paid to insuring continuity of the structure and tied reënforcement.

At the same time, the enormously destructive effect of incendiary bombs demands a vigorous development in fireproofing building materials and methods of construction, if this new threat is to be successfully countered. The so-called fireproof buildings of today have proved wholly incapable of resisting the onslaught of incendiary bombs, and far-reaching improvements in this direction are imperative if the cities of the future are to be saved from destruction by fire.

THE same is true with respect to the protection of the civilian population from toxic gas. While the development of gas masks and protective clothing since World War I has been impressive, it has by no means solved the problem of protection against even certain of the well-known World War gases, such as mustard and lewisite. It is wholly impracticable to put the whole civil population in impermeable anti-gas suits which can be worn only for two or three hours without exhaustion. A better means of protection must be found against vesicant gases already known, to say nothing of new and more powerful gases that may be used in the future.

The methods of collective protection against gas also will have to be applied to all new buildings where important activities must be carried on during prolonged gas attacks. Here the modern art of air conditioning will lend a helping hand; for once buildings are equipped for air conditioning, it will be a simple matter to add chemical filters to free the incoming air from toxic gas.

In a word, bombardment aviation has set up a challenge to modern science and engineering to devise effective countermeasures against its annihilating power if our civilization of today is to be saved from utter ruin. Just as science and engineering have in the past striven to overcome the adverse forces of nature in order to make the world a better place in which to live, so must they now dedicate themselves to finding a means of neutralizing the even greater destructive forces created by man's own ingenuity.

Editor's Note.—Writing on "Air Warfare and the Cities" in the November-December 1940 issue of Army Ordnance (Vol. XXI, No. 123, p. 237), Colonel Prentiss made the following statement regarding passive defense and air attacks:

"Since international agreements have proved powerless to cope with air warfare and since no amount of air defense can prevent a prepared and determined enemy from pushing home large-scale air attacks on cities, if he is willing to accept the losses inflicted by the defense, the importance of passive measures of protection has become increasingly apparent. With respect to the cities, perhaps one of the best answers to the menace of air attack is to make such attack *militarily unprofitable*. This can be achieved by thoroughly preparing the population to resist air bombardments by organization, training, and equipment, by evacuation of non-essential personnel from large urban communities, and, last but not least, by the removal of munitions factories, public utilities, and vital manufacturing establishments from the cities into the country."

Key to Arms Production

The Ordnance Procurement Districts at Work—Part II

J. B. Nealey*

JUST a few years ago, men of experience believed that industrial America had reached its apex of achievement. It took a major war to dispel that illusion, revitalize industry, and expand it to proportions that defy the imagination. Under the stimulus and guidance of the Ordnance Department of the U. S. Army, new plants are being built, capacity is being multiplied, old industries converted, and new industries created so quickly, on a scale so large and so vast, as to be almost unbelievable.

Today, our plants and factories are pouring out an avalanche of fighting weapons of tremendous proportions. American industry is building up an intensity of destructive might the like of which history does not record. This tornado of fighting power already is trickling into the front lines, and when it arrives at the battle fronts in full force there is little doubt but that it will crush our enemies utterly. Aside from letting contracts, converting facilities, etc., the Ordnance Department has built what is quite probably the largest organization in the world for the manufacture of fighting matériel—the Ordnance Procurement District System.

THIS is the second of a series of articles on the thirteen Ordnance procurement districts. The first article appeared in the May-June issue of ARMY ORDNANCE *(Vol. XXII, No. 132, p. 945) and discussed the Cleveland, New York, Philadelphia, and Rochester Ordnance Districts. The present article treats of the Cincinnati, Pittsburgh, Boston, and Springfield (formerly Hartford) Districts. Subsequent articles will be devoted to the Birmingham, Detroit, Chicago, and San Francisco Ordnance Districts.*—EDITOR.

The twentieth anniversary of the establishment of the present system of Ordnance procurement districts was celebrated last May 18th. Personnel of the district offices and friends in the business world gathered at luncheons throughout the country to hear radio addresses by Lieut. Gen. Brehon B. Somervell, Commanding General, Services of Supply, and Maj. Gen. Charles M. Wesson, then Chief of Ordnance. Throughout the United States, Ordnance Department officials and others also delivered addresses concerning the work of their districts.

The present ordnance procurement set-up is an outgrowth of the system used in the First World War and established early in 1918 under the direction of the late Brig. Gen. Guy E. Tripp to decentralize procurement. It was a result of intensive study of the best methods for obtaining complete munitions production throughout the country in an emergency. On May 18, 1922, Maj. Gen. C. C. Williams, then Chief of Ordnance, permanently created thirteen Ordnance district offices. Today, this same organization, greatly expanded in personnel but intact in principle, is providing munitions for victory in World War II.

Cincinnati Ordnance District

THE Cincinnati Ordnance District probably stands second to none as a desirable location for war industries, for it is strategically located between the Great Lakes and the Gulf area, and it has the further advantage of being behind the barrier of the Appalachian Mountains.

This district office was established along with the others back in the year 1922, and, from that date until 1938, things moved along more or less in a routine manner. However, in December 1938, just after Col. Fred A. McMahon became executive officer of the Cincinnati Ordnance District, there was a meeting in Washington of all the district executive officers (now known as deputy district chiefs), which meeting was addressed by the then Assistant Secretary of War, Louis Johnson. Mr. Johnson directed that the district executive officers return to their districts and start an intensive survey of all the facilities in their respective areas. The Chief of Ordnance made money available for this survey.

Thus the war effort in all the districts was started in earnest. From that day until the present, the district organizations have been growing until now there are on duty in the Cincinnati Ordnance District alone about 75 officers and over 3,000 civilians.

Already there have been negotiated in the Cincinnati Ordnance District 613 contracts for various items of ordnance with a value of $445,869,295. In addition to the above, 40 contracts in the amount of $13,230,039 have been negotiated with various arsenals and assigned to the Cincinnati Ordnance District for administration, and some 200 contracts have been assigned to the Cincinnati Ordnance District for inspection, making a total of 853 prime contracts. There are also some 5,000 purchase orders in the Cincinnati Ordnance District which must be inspected. This makes a grand total of $612,513,303 worth of work under the supervision of the district office.

The Cincinnati Ordnance District covers 121,000 square miles and takes in Southern Indiana, Southern Ohio, all of Kentucky, and all of Tennessee. The district is divided into suboffice areas. There is a suboffice in Cincinnati, Springfield and Dayton, Ohio; Muncie and Evansville, Ind.; Chattanooga and Memphis, Tenn., and Louisville, Ky. Each suboffice has at least two officers stationed there to take care of all the inspection work in that suboffice area. The entire district has 916 inspectors at present, of whom 102 are women.

The importance of the district as a machine-tool center is indicated by the fact that a considerable portion of its contracts are for machine tools. Ammunition components also make up a large proportion, with a fair sprinkling of artillery, tanks and combat vehicles, and small arms. Procurement of ammunition components is a piecemeal problem of a high order. Numerous parts are manufactured by private concerns and then shipped to "loading plants" where they are assembled and made up into complete rounds.

One of the world's largest loading plants was built and is now run by a nationally known soap manufacturer, the first

*Industrial Service, Office of the Chief of Ordnance, Washington, D. C.

company outside the explosives industry to receive such a contract. Immediately after the agreement was made, thirty engineers and production men from the various factories of this company were put to work creating this vast enterprise. They first went to Ordnance arsenals where they received special training. The whole job of shell loading was broken down and parceled out to individuals. Each was held responsible for learning with all the ingenuity and means at his disposal everything that was known or could be found out about the assigned operation or division of shell-loading work. The group then went to work on a tract of 21,000 acres of Tennessee farm land, and created the finest plant of its kind. The Cincinnati District also boasts of another new plant—the world's largest—for rolling brass and manufacturing cartridges. This concern utilizes steel-mill equipment and production methods.

THE plant-conversion division of the Procurement Service has many notable achievements to its credit. Its surveys have been most complete, both geographically and technically. Its display room, for use of prospective manufacturers is located in Cincinnati. Engineers are stationed in various suboffices throughout the district to help carry on the job of converting plants to war production. Some remarkable conversions have been effected by these engineers. For example, an automotive-accessory business, formerly interested in making running boards, is in full production on Army carbines and is further advanced in producing this item than any other contractor. Another facility which made steel saws has changed over to armor plate. Still another, which manufactured refrigerators, is producing machine guns. A computing-machine company has converted to mechanical time fuzes; a plant that made conveying equipment is now turning out armor-piercing shot and mortar shells. Another manufacturer jumped from oil-well equipment to 90-mm. cannon, and one who made stokers is now delivering shells and cartridge cases.

Dramatic examples of conversion include a playing-card manufacturer now producing parachutes and targets; another, formerly making compacts and watch cases, has turned to fuzes and carbine parts; automobile engine valves have given way to armor-piercing shot, stokers and outboard motors to 37-mm. gun carriages, and metal furniture to shells. A more grim example is that of a burial-vault and embalming-fluid concern which is producing shell. A clock company has contracted to deliver fire-control instruments, for which it will grind the lenses and prisms.

Highlighting the problem of conversion is the story of a company blessed with an idle staff of top-flight engineers. Willing to take any kind of a contract that would put these men into production, they accepted an order for carbines. Being short of the necessary manufacturing facilities, they successfully negotiated the subcontracting of sixty out of the sixty-three parts involved in this gun. Due to their success in getting the job under way quickly, they were allowed to coöperate with the Ordnance Department in the development of a submachine gun. On this item, they have subcontracted seventy out of seventy-three components. This gun, which has just been standardized, is remarkable for its simplification of design. Its receiver, unlike that of the ordinary gun requiring seventy to eighty machine operations, is made from a single piece of welded tube.

Production control of the Cincinnati Ordnance District is not on a fire-alarm basis but is organized as a true production-planning department, similar to that of any large, successful corporation. Here the ordnance contractor is both guided and checked as to the effectiveness of his own progress. Since November 1940, the Cincinnati Ordnance District has maintained a section concerned solely with production. This group now numbers 175, including 26 production engineers whose exclusive duty is fighting the battle of production.

ARMOR-piercing shot constitute an important part of the local ammunition program. When it became evident that large production would be required on this item, the Cincinnati District called on a company normally engaged in making automotive valves, valve guides, pistons, and other close-tolerance work for the automobile industry. It was felt that this company could make the necessary conversion with a minimum of new equipment. By a novel method of manufacture, critical alloy steels have been greatly conserved and a high production rate of armor-piercing shot achieved in a short time.

In this case, a production engineer was specially delegated to follow every technical problem incident to getting production started. The equipment-expediting division gave specialized attention by long-distance calls, teletypes, and personal visits almost daily in order to bring in the special additional equipment needed. Material schedules and delivery dates were verified and improvement insisted upon where necessary, so that despite hell and high water production got under way. But regardless of the best planning, the unexpected frequently happens. This time, because of the novel method employed, the life of the forging die steel had been overestimated, and a production shutdown was threatened soon after the starting date. The Cincinnati Ordnance District had to work something like magic to keep this company supplied with special die steel adequate for its accelerating rates of production. Most of the steel companies and steel warehouses in the country were contacted to meet the situation; there was no loss of production, and today this company is the outstanding producer of armor-piercing shot.

In so far as possible, subcontracting is anticipated and required when a contract is negotiated. But occasionally subcontracting must be resorted to after production has started in order to break some unforeseen bottleneck. A case in point is that of a company engaged in the manufacture of large antiaircraft guns, on which job the contractor developed a serious lack of balance in his operations. The gun breechblock was the production snag since it involved a complicated sequence of planing, milling, profiling, and boring operations. When a competent subcontractor for breechblocks was brought into the picture by the Cincinnati Ordnance District, the balance was established, and the Army is getting its guns.

Pittsburgh Ordnance District

STEEL is one of the essentials of modern warfare, and the name "Pittsburgh" means steel. However, the Pittsburgh Ordnance District, which supervises operations in Western Pennsylvania, Western Maryland, West Virginia and a small portion of Eastern Ohio, delivers many of the 13,000 items listed in Ordnance Department requirements.

Here, among many other manufacturers of war material, are producers of machine tools, guns, gun carriages, armor, small arms, ammunition, optical elements and optical glass, besides steel and aluminum. The number of prime contracts and subcontracts in which the Ordnance district office is conducting production service is over 5,000, and the value of

Signal Corps

THE M3 MEDIUM TANK—A PRODUCT OF THE ORDNANCE DISTRICT SYSTEM

such contracts is estimated to be nearing the $1,000,000,000 mark.

Col. James L. Guion, deputy district chief, is the able officer in charge. Today, the energetic personnel of his district occupies five floors of the Chamber of Commerce Building and consists of 65 officers and 2,700 civilians. Under the supervision of his staff, the district maintains and operates a gage laboratory which designs, repairs, and checks gages; conducts training courses for Army inspectors of ordnance, and develops procurement procedures and plant-protection policies among a host of other matters.

The work of an Ordnance district is not only to place war orders but also to facilitate the production of such orders. Hence the district's offices also include divisions covering field service, finance, inspection, property accountability, and many other matters. As a result of these services, today many of the bottlenecks of ordnance-material procurement have been ironed out.

Primarily, this district produces semifinished material. It is estimated that approximately one-fifth of the manufacturers of gun tubes in the United States are located here. The tubes are forged and rough-bored in Pittsburgh and shipped elsewhere for completion. Here, too, are producers of practically all the parts which go into tanks. Hull castings, turrets, guns, threads, optical glass, and optical elements are a few of such parts produced in this area and forwarded to other destinations for assembly. The same situation is true in the case of scout cars and half-track combat vehicles. This district contains the world's largest producer of armor plate. Armor for practically all purposes is turned out—for tanks and other combat vehicles, for gun shields, and for many other items.

Ammunition manufacturers of sizable proportions are also located here. Practically every type of shell and bomb is forged and finished. One such producer recently produced its one-millionth bomb, its two-millionth shell, and its five-millionth item of ordnance material. This record has been established in spite of the fact that this company had to retool prior to starting production on such items. The quantity and quality of the work turned out is shown by the example of a crew in another company, which, in an 8-hour shift, produced two thousand one hundred and eighty-one 105-mm. shells, out of which number only one shell was rejected. A $13,000,000 order for 1,000-pound bombs was placed with another manufacturer. This company had to retool from its consumer business and is now producing on the bomb order.

AS in the case of other districts, the Pittsburgh Ordnance District also has been confronted with the question of conversion. In order to facilitate the changeover, a display service showing many ordnance items was established. By seeing the particular item which he is going to produce, many a manufacturer has been able to visualize better and thus solve, with the aid of the various divisions of the district office, the conversion problems before him. There are numerous examples here of conversion. In many instances the solution was reached through practical means. Toy manufacturers are now producing canister. Former automobile dealers are producing hand-grenade fuzes. Meter companies are turning out shells and primers. A bedding company now makes links for machine-gun belts. One of the largest food companies has turned to making canister. Another company which was producing thermostats for gas cooking stoves is manufacturing boosters for bombs. A company formerly making burial vaults is now turning out 100-pound bombs.

The complexity of the problems involved in such conversions is well illustrated in the case of one company now working on the production of gun carriages. These carriages cost approximately $630,000 each, which indicates to some extent the multiplicity of their parts and the questions which had to be solved. Another company has turned to the manufacture of combination gun mounts for tanks, and shortly these mounts will be rolling off what is expected to be one of

the fastest production lines in the country. Still another company has installed a mechanized shell-loading line a quarter of a mile long. This line is believed to be the longest line of its type in the United States.

The Pittsburgh District could, if the need arose, furnish all the Ordnance Department's requirements for canister. Manufacturers in the district have established quite a name for themselves for the production of armor-piercing shell. If it were possible to release the figures showing the percentage of the nation's shell steel produced by this district, the figures would be astounding. The district has installed steel allocation procedures and one of its engineers is constantly in the field surveying the scrap-iron possibilities and alleviating this troublesome problem.

Subcontracting has, to a large extent, helped to solve many of the bottlenecks of conversion and has also helped to facilitate the flow of deliveries. Today, the Ordnance district office services an estimated 3,400 subcontracts, thus spreading the work and the consequent benefits as well as stepping up the rate of production.

It has been said that World War I resolved itself into a battle between the steel production of the Ruhr and Pittsburgh—and Pittsburgh won! The personnel of the Pittsburgh District and the entire Ordnance Department now have dedicated themselves to proving the age-old proposition that "history repeats itself."

Boston Ordnance District

INDUSTRIAL background is the forgotten component of skill until a national emergency—nay, a world crisis—demands that this nation take sides in a struggle that may well determine which mode of life is to survive. New England, with an industrial background reaching back to the days when another freedom-loving people set foot on Plymouth Rock, is traditionally determined to uphold its heritage. "Production and more production" has become the axiom to defeat the Axis among conservative New Englanders. It is in the skill and experience factor that New England comes into its own. In paper mills, shoe factories, furniture plants, cotton and woolen mills, machine shops, and any number of industrial establishments, thousands of craftsmen are converting their peace-time skills to the more grim task of making arms for the Army.

New England's machine-tool industry all but passed into obscurity during the hectic days of the depression, as did many other businesses and skills. Not only did the output reach a new low, but young men, mechanically inclined and suited, found no jobs as apprentices. Older men were thrown out of work, were retired, or went on relief. It was this condition of chaos that confronted the nation only a year or so before Pearl Harbor. The wild scramble back to the machine-tool industry brought with it a number of ensuing bottlenecks that only recently have been smashed. New England, suffering for more than ten years before and after the height of the depression, has done its share in helping Ordnance production experts in the Boston Ordnance District solve an industrial problem in a way that compares admirably (from a viewpoint of the general war aim) with General MacArthur's heroic stand on Bataan Peninsula.

Machinists from all walks of life leaped into the picture again—men who had been shelved because of advanced age, men who had found refuge on relief, and young men waiting for just such a chance to don greasy overalls. Trade schools, like Boston's famous Wentworth Institute, regained all their earlier importance. Courses were given day and night as the 'round-the-clock movement became more than just an expression. Large universities in the Boston district and elsewhere, such as Harvard, Massachusetts Institute of Technology, Northeastern, Tufts, Boston College, and Boston University, joined ranks to offer more than sixty courses in engineering, science, and production problems.

THE job of coördinating Army production in a large section of the New England area is in the hands of the Boston Ordnance District, with Col. James S. Crawford as deputy chief. Colonel Crawford came to Boston in 1935 as executive officer under orders signed by the then Chief of Staff, Gen. Douglas MacArthur. Since 1935, the Boston Ordnance District has grown by leaps and bounds. From a few officers and civilians during the postdepression period the personnel has been enlarged to include about 50 officers and nearly 900 civilians. This comparatively small working force controls Army ordnance in production in Maine, Vermont, New Hampshire, Rhode Island, and all of Massachusetts with the exception of the four western counties of Hampshire, Hampden, Franklin, and Berkshire.

Since Pearl Harbor, production figures have taken on gigantic proportions. On January 3rd, to take only one day, more than $32,000,000 in war contracts were placed over the telephone between the hours of six and ten in the evening. During the month of January, more than $3,000,000 a day in contracts for ordnance items were released, and in February the figure jumped to $4,796,000 a day!

The question once asked of manufacturers, "What are you making at your plant now?" has taken a new note of expediency in the query, "What *can* you make with your machinery, your personnel, in a plant the size of yours?" To sit in on a conference of ordnance engineers and manufacturers would be to reveal a metamorphic struggle of industrial activity—a struggle of minds in the all-important task of converting peace-time machines, personnel, and buildings into arsenals of production. It is obvious that with the increase in the number of subcontractors—with the spreading out of manufacturing facilities—there will be a corresponding increase in production all along the line. Eventually there will be full utilization of all machine power, all man power, and all brain power available in New England. When this achievement in New England is multiplied thirteen times—once for each ordnance district in the nation—there will be a peak of production that no nation in the world can equal.

The production problem has been one of conversion from the very first, only efforts now are being made to include manufacturers who did not feel that their equipment was fitted, even remotely, for war production. Take, for example, a textile mill which has become world renowned for its textile machinery. Today there is being manufactured at that industrial beehive the carriages for antitank guns. Or take the case of a pressing-machine company where high-explosive shells are being turned out by the thousands. A huge shoe-machinery firm is turning out small cannon; a national fireworks company and a lock maker are manufacturing ammunition components; a railroad-car builder is producing parts for tanks; a world-famous manufacturer of textile machinery has turned to howitzers; an equally well known maker of printing presses is occupied with shell; a pressed-steel concern now turns out machine-gun magazines. Helmet linings are coming from a shoe company, cartridge cases from a metal-stamping company, and so on through a long list.

Signal Corps

THE 90-MM. ANTIAIRCRAFT GUN—A PRODUCT OF THE ORDNANCE DISTRICT SYSTEM

With regard to the machine-tool industry, the Boston Ordnance District has had a mammoth job on its hands since it is situated in the heart of that section of the country devoted to this precision industry. Crys went up from manufacturing plants from the rock-bound coast of Maine to the Golden Gate for tools with which to begin production on war matériel. The machine-tool industry is unusual in that it is the basic industry for all other manufacturing; by it, all other production governs its precision and its speed. Before a single gun, shell, or tank can begin its long jaunt down the production line, machine tools must have been made to turn out the many component parts of each mechanism. New England has long been recognized as the hub of this industry. Leading toolmakers have set up plants here because the type of labor necessary was available as in no other single area in the country. Names like the Starrett Company, Brown & Sharpe, Norton, Potter & Johnson, Blanchard, Jones & Lamson, Union Twist Drill, Lapointe, Prentice-Reed, Kingsbury, Morse Twist Drill, and the Heald Company are as important to the all-out production effort as the names of leading generals are to the work in the field. The revival of the industry is being carefully watched in New England, and reports have it that it will never be allowed to drop to the depth experienced during the depression years.

LABOR, of course, is the other important factor in production—the human element that goes to make up complete synchronization between management and machines. Labor has coöperated splendidly all along the New England front, as well as in other sections of the country. Examples evident in relation to women employees in Massachusetts and Maine deserve special comment because they indicate a trend or transition that may become a vital matter in production before this war is won. In these two states where special contracts for matériel were in effect, it was learned that additional working hours for women were necessary in order to give the Army vital items on a definite date. Since the law reads that women may not work more than nine hours a day and forty-eight hours a week, a labor bottleneck loomed ahead. But through emergency powers granted to the respective governors and the coöperation on the part of state labor heads, the law has been relaxed in special, specific cases. This does not mean that the labor laws governing women are being scrapped—it means only that where the Boston Ordnance District has requested more production to meet specific needs and these needs cannot be met without more hours of work for women, the governor and his labor chief relaxed the law to allow for the completion of the contract *on time*. As the production picture grows more and more acute, other similar cases are expected to confront labor in the future. The Boston Ordnance District continues to feel confident that labor will do its share, and more, to supply arms for the valiant men in the field today, and for those who will follow.

Springfield Ordnance District

CONTRACTS totaling more than $600,000,000, which have been negotiated in the Springfield Ordnance District, indicate that President Roosevelt's plans for the all-out use of individual facilities to provide fighting tools for the Army are being carried out here, according to a report made recently by Col. W. S. Broberg, deputy district chief of the Springfield Ordnance District. The report further stated that contracts totaling over $215,000,000 had been negotiated in the Springfield Ordnance District since the United States entered the war. This is an average of more than $3,000,000 for each working day during the period covered in the report's statistics. (Until recently, the Springfield District was known as the Hartford District.)

The Springfield Ordnance District is one of the smallest districts geographically, covering as it does only the State of Connecticut and Western Massachusetts, but it is one of the most important in the war procurement plan, in view of the

highly centralized and specialized industry found in this area. Here, in privately owned plants working under Government contracts, are produced the Garand rifle (or the semiautomatic M1, as the Army prefers to call it), all types of machine guns, cartridge and shell cases, artillery projectiles, ammunition components, cannon, gun carriages, etc.

The spread of work throughout the district is shown by the fact that the Springfield Ordnance District office has under its supervision over 1,200 different prime contracts and over 3,000 subcontracts, placed with about 200 different prime contractors and over 300 subcontractors.

Colonel Broberg states that this district is capable of absorbing the heavy load which is being put upon it under the all-out program. An immediate step taken was to call on certain key ordnance manufacturers, who had not already done so, to go on a 24-hour, 7-day-week basis in order to take full advantage of their capacity. In addition to this, a number of manufacturers who were making both ordnance items and commercial products have now changed over their entire plant capacity to ordnance production.

For the past two years, engineers from the district office have been going out into the far reaches of the district, checking the ordnance productive capacities and machine-tool equipment of all potential ordnance manufacturers, including the so-called "little fellows." As a result, the district office has been able to place its prime contracts quickly and then to help its prime contractors in locating specialized machine tools or equipment for parts of the contracted item. The prime contractor for one item—a submachine gun—has awarded subcontracts to fifty-two different firms. This is but one example of the extent of subcontracting.

In order to speed procurement, the district offices have been empowered to award contracts up to $1,000,000 without prior approval from Washington. The districts also authorize the start of production on the basis of letters of intent, rather than make it necessary for the contractor to wait for his formal contract.

IN the same way that the Ordnance Department of the Army decentralizes its procurement to thirteen district offices (of which the Springfield Ordnance District office is one) for greater efficiency and better liaison with manufacturers, the district office has established suboffices in Hartford, Bridgeport, New Haven, and Waterbury. The personnel in these suboffices includes field engineers who check production in all the ordnance-producing plants within a specified area around the suboffice. These field engineers have the dual responsibility of helping manufacturers maintain the Government's required production schedules and of keeping the district office informed of the manufacturer's progress on his schedule. The field engineer has to spot any potential bottlenecks and delays before they occur and take immediate steps to remedy the condition through the manufacturer or the manufacturer and the district office working together. The suboffices also see that manufacturers have proper priorities on raw and semifinished materials, as well as machine tools, in order to maintain the steady flow of production required.

New England was the cradle of the firearms industry. Eli Whitney, of cotton-gin fame, was the father of the principle of manufacturing interchangeable parts and first applied this principle to the production of muskets for the U. S. Ordnance Department. Gradually, throughout the years a great industry grew up here which turned out military rifles in war time and perpetuated itself by making sporting arms in times of peace. Today, this industry, represented by such nationally known concerns as the Remington Arms Company, the Winchester Repeating Arms Company, Colt's Patent Fire Arms Manufacturing Company, Smith & Wesson, Savage Arms Corporation, Marlin Firearms Company, Auto-Ordnance Corporation, High Standard Manufacturing Corporation, etc., are now turning out military firearms in quantities heretofore thought impossible.

WITH the help and coöperation of Ordnance engineers, practically every kind of manufacturing plant is being converted to the production of fighting material, and a number of them have come a long way to effect this conversion. For instance, who would ever think of a silk mill as a source of war items? Yet such is the case. A maker of high-quality silver tableware is producing cartridge clips for the Garand rifle. A world-famous sporting-goods firm is now turning out armor-piercing shot—of all things. Ammunition components are "duck soup" for watch and clock makers. Famous lock concerns and equally well-known typewriter firms are making ammunition components. Printing-press builders are versatile and have turned their machines and personnel to the making of a number of ordnance items. Makers of such diversified products as gasoline pumps and dictaphones are now turning out fire-control equipment. A prominent concern in the toy field now manufactures parachute flares, while the lipstick-container division of a big brass company is today working on cartridge cases, boosters, primers, etc.

The little fellow, too, is coming into his own, thanks to a renewed interest on the part of the various Ordnance districts. In the Springfield District, the Procurement Division recently organized a section for this very purpose. It is composed of engineers of wide experience in manufacturing to act as advisers to help small shops obtain subcontracts and then to aid them in converting their equipment to the required type of production. For instance, a small shop repairing aircraft engines now roughs out engine parts for new aircraft engines. The Springfield Buick Company, an automobile sales concern, converted its repair shop, bought a few new tools, and is now making several small parts on subcontract. An automobile-parts company is producing armor-piercing cores in mass quantities—and so on down a long and impressive list. A good example of subcontracting in this district is the Auto-Ordnance Corporation, makers of the famed Thompson submachine gun. This company has farmed out parts to fifty-two different subcontractors.

Birthplace of the machine-tool industry, New England in general and the Springfield Ordnance District in particular have been made famous by such names as Pratt & Whitney Company, Greenfield Tap & Die Corporation, Bullard Company, Farrell Birmingham Company, Van Norman Machine Tool Company, New Britain Machine Company, Geometric Tool Company, Waterbury Farrell Foundry and Machine Company, Hendey Machine Company, Baird Machine Company, Bausch Machine Tool Company, Noble & Westbrook Company, Taylor & Fonn, Millers Falls Company, and so on. All these are now working on machines to produce ordnance and defense material.

EDITOR'S NOTE.—The addresses of Lieut. Gen. Brehon B. Somervell, commanding general, Services of Supply, and of Maj. Gen. Charles M. Wesson, former Chief of Ordnance, on the twentieth anniversary of the establishment of the Ordnance district system are published on page 92 of this issue.

The Battle of Libya

IN all the British Commonwealth's land successes of this war, tanks and motorized high-speed armored troops have been the deciding factors. The British invested the Italians' East African Empire with motorized and armored forces, capturing 150,000 prisoners; General Wavell, with tanks, motorized infantry, armored cars, and air support, destroyed the Italian army in Libya, taking 135,000 prisoners; and Britain's other armies in the East are mainly high-speed motorized and tank forces.

British tanks are fighting along a vast semicircular front that extends from the Libyan border to the shores of the Caspian Sea, south of the Russian oil base of Baku. At the southern end of the semicircle, Commonwealth forces, based on Cairo, are fighting the Battle of Libya. The central section of the front runs along the Syrian-Iraqi frontier to meet any attempted sudden attack by German forces based on Bulgaria, and the right wing skirts the Russian Caucasian frontier to join the Russian front defending the Caucasus and Baku.

Egypt and India are the British Empire's great military bases in the East. Egypt, which has no natural resources for the creation or maintenance of a modern mechanized army, is being constantly supplied by Great Britain, Canada, and South Africa by ships steaming around the Cape of Good Hope and up through the Red Sea, now dominated by the Royal Navy, or coming in convoy through the Mediterranean. Over these routes is flowing also, in an ever-increasing stream, a huge volume of supplies from the Defense Aid Program of the United States. American tanks have already distinguished themselves in desert fighting, and American Ordnance officers and men have set up maintenance shops in Egypt to "keep 'em rolling."

Modern mechanized armies need rapid and reliable means of communication, and the British armies in the Middle East have improved the highways and rail transport leading along the North African coast to the Libyan border so that they now can carry any volume of traffic. It has been decided to join the present northern terminus of the Palestine Railway at Haifa with the southern terminus of the Mediterranean branch of the Taurus Railway at Tripoli in Syria.

The Battle of Libya, which has flared up again with renewed intensity in recent weeks, is one of the greatest tank struggles in history. Under incredibly severe conditions of climate and terrain, and with staggering problems of supply and maintenance, the British tank and motorized forces based on Egypt time after time have repulsed attacks by the German armored forces under Gen. Erwin Rommel and have driven deep into enemy-controlled territory. The present phase of the battle, now in progress, may decide, once and for all, the fate of North Africa, the Suez Canal, and the nations of the East. On the following pages are shown some of the types of Britain's armored equipment now engaged in this death struggle in the sands of Libya.

Libyan Proving Ground

The Libyan desert is the ultimate proving ground for mechanized equipment. Sand storms, extreme heat, and rocky terrain such as the light tanks shown above are negotiating, make short work of any but the best-quality matériel. British and American ordnance crews work day and night to keep the tanks rolling and the antitank guns, like the British type below, firing.

Mobile Fire Power

The ubiquitous British Bren gun carriers are shown above "mopping up" the ruins of Fort Capuzzo in the western desert. These track-laying, lightly armored vehicles transport men and machine guns at high speed over all types of terrain. The 16-ton "Valentine" tank, below, carries a crew of three and is armed with a Besa quick-firing gun and a 2-pounder.

German Casualties

A German tank from General Rommel's "Afrika Korps," above, lies battered and silent in the desert—a victim of the British armored forces. Note the low silhouette, bogie arrangement—and the shell hole through the rear of the turret. An armored, half-track German troop carrier, below, its front wheel shot away and supplies scattered, is another desert warfare casualty

The Spoils of Victory

Like David surveying the corpse of Goliath, the Indian Bren gun carrier, above, inspects the smoking remains of a German tank knocked out in the Battle of Libya, while below, British enlisted men examine two more derelict German tanks and prepare to salvage valuable parts and equipment. In desert warfare, lack of spare parts may mean defeat for an armored unit.

Britain's New Motorized Forces

Speed of tank movements is increased and tank maintenance is decreased by bringing the fighting vehicles up to the combat zone on tank transporters, such as the one shown above hauling a British Mark IVA cruiser tank. Below, 25-pounders of a British armored division, with caissons and prime movers, are shown massed with tanks and troops before a review.

Tank Maintenance in the Desert

Tank maintenance must go forward on schedule, even in the desert. The huge tank transport, above, is hauling a 26-ton British "Matilda" tank to the repair shops at Tobruk for overhauling. Below, although far from base, maintenance goes on in a sand pit, dug to conceal the tank from enemy ground observation; the tank also can be covered to hide it from aircraft.

Supply—Lifeblood of Victory

England, heart of the British Empire, is sending a constant flow of fighting tanks along its arteries of supply to defend its far-flung Eastern outposts. A trainload of Mark V "Covenanter" tanks is shown above leaving an assembly plant en route to a seaport, while below, tanks are loaded aboard ship at an English quayside for transport to the Eastern battle front.

"Enough and On Time"

The Ordnance Record in This War—A Tribute to Teamwork

ON this and the following pages is published a complete verbatim transcript of the proceedings of a testimonial dinner in honor of Maj. Gen. Charles M. Wesson, who was to retire as Chief of Ordnance, U. S. Army, May 31, 1942. The function was held under the auspices of the New York Post, Army Ordnance Association, in the grand ballroom of the Waldorf-Astoria, New York City, on May 28, 1942. More than 1,700 members of the Association and their guests were in attendance. Maj. C. Stewart Comeaux was chairman of the dinner committee. R. E. Gillmor, president of the Post, was the toastmaster. The speakers were K. T. Keller, president of the Chrysler Corporation, Detroit; Lieut. Gen. William S. Knudsen, Chief of Production, War Department; Bernard M. Baruch, World War chairman of the War Industries Board; Maj. Gen. Levin H. Campbell, Jr., Chief of Ordnance designate; Robert P. Patterson, Under Secretary of War; Brig. Gen. Benedict Crowell, president, Army Ordnance Association, and General Wesson, the guest of honor.

High tribute, and all of it well deserved, was paid to the Chief of Ordnance. He was awarded the Army Ordnance Association's highest honor, the Williams Gold Medal for Distinguished Ordnance Service. He was also awarded an oak-leaf cluster for his Distinguished Service Medal won for service in the World War.

But this tribute was more than a testimonial to the effective work of one man. It was distinctly a commendatory appraisal of the loyalty, energy, and ability of the thousands of men and women of the Ordnance team in Government service and in private industry, in military uniform and in civilian dress, in arsenals, at machines, behind executive desks, in field depots, with training cadres, and on battlefields. Indeed, General Wesson, in acknowledging the praises which were tendered him, graciously passed them on to all his coworkers throughout the far-flung Ordnance organization. "Enough ordnance matériel and on time" has been the result of the untiring efforts of the Ordnance team captained by a gallant leader, General Wesson.

—EDITOR.

THE testimonial dinner meeting in honor of Maj. Gen. Charles M. Wesson was called to order by Maj. C. Stewart Comeaux, of the New York Post, Army Ordnance Association, who was chairman of the dinner committee.

THE CHAIRMAN: General Wesson, distinguished guests, and gentlemen. It is with a deep personal pleasure, as chairman of the committee of the New York Post of the Army Ordnance Association, that I welcome you to this historic meeting. We of the committee appreciate the opportunity afforded the New York contingent of our great national society to honor an illustrious officer of the Army of the United States.

The committee is grateful, too, to the members of the Army Ordnance Association who have loyally coöperated in making this testimonial dinner so successful. In numbers, we have taxed the capacity of this beautiful ballroom. More than 1,700 members and their friends are here assembled in tribute to General Wesson and to aid Army Emergency Relief. As you know, all profits from this dinner will be given to that fund.

It is my function, as chairman of the committee, merely to greet you and to welcome our distinguished guests who are assembled here on the dais. We of the New York Post committee are honored to be a part of this gathering tonight to pay tribute to our guest of honor, to his delightful personality, his outstanding leadership, and his splendid contribution to the great Victory Program.

But now it is my pleasure to introduce and to give you an opportunity to greet for the first time the newly elected president of the New York Post, who will be our toastmaster. May I present Mr. Reginald E. Gillmor. (Applause.)

THE TOASTMASTER: General Wesson, honored guests, members of the Army Ordnance Association, and friends. There come occasions in the lives of all of us when to confer honor upon whom honor is justly due is not only a duty but a deep personal pleasure. Such an occasion brings us together here tonight in tribute to our guest of honor.

General Wesson is about to terminate one of the most successful tours of duty of any officer in the history of our Army. I understand there is an iron-clad law which says that an Army officer must retire at the age of 64. Somebody should check the birth certificate in this case—it must be at least ten years too soon! (Applause.) However that may be, General Wesson's term of office as Chief of Ordnance will officially terminate May 31st, three days from today. He became Chief of Ordnance just four years ago, when the military armament of the United States was at the very threshold of a period of development the like of which has never been seen in the history of any civilized country.

The tributes to General Wesson for his administration of that great program during these four historic years can be adequately spoken only by great and eloquent leaders. Consequently, we of the New York committee have gone to industry, to the Army, and to civil life, from which leaders have come to us to appraise here, before this impressive gathering, the work and character of the man whom we honor.

So it is my pleasure to present to you the first of our speakers, a man whose name is linked with great achievement throughout American industry. He is the president of one of our largest automotive manufacturing companies. He was quick to turn the tremendous power of his organization to the manufacture of armaments, so that today the Chrysler Corporation is a leader in war production. The inspiring genius of that organization is the man who fills the

important office of its president. His name is synonymous with all that is good for the welfare of our country. It is my pleasure to present to you our first speaker, Mr. K. T. Keller of Detroit, president of the Chrysler Corporation. (Applause.)

Address of Mr. K. T. Keller

MR. KELLER: Thank you, Mr. Toastmaster. General Wesson, members and guests of the Army Ordnance Association. It is a privilege to speak on this occasion. What I shall say to General Wesson and about him represents, I am sure, not only my own observations but those of every other person in American industry who has had the opportunity to know him, to work with him, and to see something of the enormous task he has accomplished.

Ordnance production in this country will shortly exceed anything that any combination of enemy powers in the world can turn out. (Applause.) Being a modest man, one might think from what General Wesson says that he himself had little if anything to do with that achievement, but you and I know better. He says the Ordnance effort today is the culmination of the labors of the last forty years; that when he became Chief of Ordnance in June 1938, he found the Department soundly organized for either peace or war; that the basic organization has remained unchanged during the last four years, and that the procedure of the planning years has been followed almost to the letter.

Maybe so, General. That may all be true. (Applause.) Certainly those of us in industry who have first-hand experience with your associates in the Ordnance Department, with their knowledge of the jobs to be done, their willingness to explore the facts with industry's representatives, and the fairness of their dealings with us, will agree that as Chief of Ordnance you have had able assistance.

Yet I believe that these same officers will also agree with us that after June 1938 some things began to happen in this country for which the American people, the people of the United Nations, and the men in our military fighting forces owe General Wesson a debt of lasting gratitude. (Applause.)

One new, significant thing happened in terms of getting the guns, tanks, ammunition, and other weapons and supplies that our fighting Army needs. I have not seen that one thing better or more simply expressed than by General Wesson himself. Recently, as the guest of honor of the Newcomen Society of England, to which I have the honor to belong, General Wesson gave a review of American military armament since 1900, when he received his commission as a second lieutenant. So far as he personally is concerned, I think he indulged in some gross understatements, but in this address he also stated very clearly one of the fundamental reasons why American industry, coöperating with the Army and the Navy, has been able to do such a significant job of arming this country.

General Wesson said, and I quote: "Early in my tenure I adopted the policy of going into partnership with American industry on an accelerated research and development program, utilizing the outstanding personnel and facilities of private industry in coördination with the trained Army and Ordnance personnel. This partnership has proved to be a very happy one indeed, in that commercial companies, under the guidance of our experienced officers and engineers, have been able to produce quickly these new required types, even though such companies and their highly competent engineers have had no previous experience in such work."

Whatever we may say on this testimonial occasion, the results of that policy, which we now see rolling off the assembly lines of industry, constitute a tribute to General Wesson far more eloquent than anything you and I can say about him tonight. (Applause.) His outstanding successes in putting that policy into effect, in bringing about this great joint effort of American industry on the one hand and the Ordnance Department on the other, and in making it work, has been the determining factor, not only in accelerating our war production but also in establishing and maintaining it at high-quality standards.

General Wesson would be the last to deny that without the engineering genius and productive ability of American industry his program could not have been realized so quickly and so extensively. He himself has been generous in his praise of what industry has done and is doing. He recognized that with only the limited money available to him for research prior to the war, the Government arsenals could not do all the work necessary to prepare for actual war conditions and that industry would have to carry that load. Any good Ordnance Chief would say that.

The secret of General Wesson's genius, however, was the spirit in which he approached this partnership with industry to which he refers. He knew how to trust men to do what he wanted done. He inspired confidence on the part of industry by having confidence in the people he asked to help him. He has an extraordinary sense of men's capabilities and the courage to give them responsibility. It took a soldier's courage to go to a manufacturer of automobiles that weigh a few thousand pounds and ask him to build tanks which weigh twenty-eight tons!

He realizes the essential fact that it is people—individuals—who get things done. He did not look for miracles, and the result was that he got them. After all, the men responsible for the performance of American industry approached their part in the defense effort, as well as in the war effort, with a high sense of duty to their country. They are aware of their obligations to their employees, their stockholders, and the public, but I think in most instances it has been clearly demonstrated that American victory in war is their paramount consideration. General Wesson rightly recognized that he did not have to argue about their patriotism—he assumed it; and, in terms of the production he sought, he was rewarded with such results as only patriotic zeal could make possible. (Applause.)

ONE might try to indicate General Wesson's accomplishment in various ways as an administrative task, considering the fact that for twenty years, from 1918 to 1938, the available appropriation for the Ordnance Department was $12,000,000 a year. In our own company we normally spend more than that annually to tool up for new models. Yet, with this relatively meager sum, much of the basic engineering of our country's current huge ordnance output was developed. If you visited the fine arsenal at Rock Island, as I did when we undertook to build medium tanks, you would get some conception of the skill and thoroughness with which they did it. Most of the new weapons of this war were developed in that period.

Now contrast the $12,000,000 of the pre-1938 period with Army Ordnance appropriations of more than $23,000,000,000 for the emergency period thus far, and you get some idea of the tremendous, almost overnight, expansion required of the Ordnance Department and its industry partner.

THIS is an impressive measure of an impressive achievement, but I prefer to look at it in other terms. I suggest that from industry's viewpoint there are three major factors in the success of General Wesson's administration:

The first factor is his recognition of the engineering basis of ordnance production. This involves the engineering skill and experience on the part of Ordnance officers with respect to the weapons to be built and the engineering productive skill and experience on the part of industry in designing things to be made by quantity methods. General Wesson realized that in the last twenty-five years thousands of engineers and mechanical minds in industry have been developing new machines, new tools, new methods, and personnel skilled in their use, as well as a supply inventory to keep them going. What he did was to marry these two resources of trained talent—the men who knew what was wanted and the men who knew how to do what was necessary to produce in volume.

The second factor is the character of the personnel with whom General Wesson surrounded himself. They know their jobs. They are on their toes. They know what industry can do and cannot do. General Wesson realized the business man's approach to the problem of ordnance production on a war scale. He sought to clear away the obstacles. He encouraged his associates to see the other fellow's viewpoint. His expansion of all the Ordnance districts, and the resultant larger contacts of the industry and Ordnance people, produced a mutuality of understanding that helped to smooth the actual production processes. A little over a year ago, General Wesson came out to Detroit to receive the first medium tank fully equipped and ready for combat. He made a speech to us that day, and among other things he said this about the Ordnance Department: "We had officers, both active and Reserve, who spoke the language of business and industry and who knew the problems of labor. The old barriers between the business man and the soldier were broken down, and there will be none to deny that these achievements we celebrate here today could not have been attained if these outmoded barriers had remained."

The third factor is that General Wesson encouraged industry to come and do a job. He realized that industry had a great deal to contribute in addition to its productive capacity—it had inventive skill, great engineering laboratories, men with remarkable technical experience in machine and tool design. The result is that our engineers and our master mechanics in the shops do not hesitate to suggest to the Ordnance people better ways of doing things, more economical processes, and quicker methods—methods that save time and material and yet maintain or improve the quality of performance.

When the story of this war's ordnance production is told, it will include contributions of this nature that today censorship necessarily restricts. As Donald Nelson [chairman, War Production Board] pointed out a few weeks ago, the tricks and short cuts that once gave us an increase of output of luxuries and conveniences are now being just as effective in boosting our production of weapons.

General Wesson, these are only some of the fruits of your courageous work. The full story of it is a story of action—action in the arsenals, in the laboratories of industry, in the war plants which you have fostered, and on the proving grounds—but most of all, action on the part of men at the outposts of democracy who wield the weapons that you have forged to preserve our American institutions. (Applause.)

THE TOASTMASTER: Mr. Keller, we are all very grateful to you for your inspiring address and for the expression of sentiment about our guest of honor, in which all of us concur most heartily.

The second speaker on our program this evening is somewhat in the nature of a surprise. He is a great production genius, and now wears the uniform of a lieutenant general of the United States Army. He is responsible for all production throughout the War Department. Less than two years ago, in this ballroom, he brought to the members of the Army Ordnance Association a most inspiring and courageous message. Since then, he has done great things for his country, and all of us are eternally grateful to him. As a close associate of our guest of honor, as one who has steered the vast production program from the beginning, General Knudsen is without peer anywhere. It is most appropriate that he speak to us briefly on this program in tribute to General Wesson, and I am happy, indeed, to introduce him to you. Gentlemen, Lieut. Gen. William S. Knudsen. (The audience arose and applauded.)

Address of Lieut. Gen. William S. Knudsen

GENERAL KNUDSEN: General Wesson, Mr. Gillmor, honored guests, and you fellows that make the stuff, out there in front. (Applause.) This may be General Wesson's fourth anniversary, but it is my second! (Applause.) It was just two years ago this week that I undertook to come down to Washington without knowing what I was going to do or how I was going to do it, and one of the first men I had contact with was our guest of honor. He knew all about guns, and I did not. He knew all about powder; I thought powder was something you got in a pepper box (laughter), but I soon found that it wasn't. He knew something about tanks; I did not.

So little by little I went to school to General Wesson by getting a drawing and comparing that with something he called a "schedule of requirements," and I remember quite vividly that we got the first appropriation, and it was of the staggering sum of a billion and a half dollars. That was a staggering sum in 1940. It is not so staggering now (laughter); in fact, I took a look at General Wesson's part in the requirements, and it is up to something like twenty times what we talked about the first time.

Now when you think of the amount of work that has been placed all over this United States, it had to be done by some organization, and evidently General Wesson, our guest of honor, had had the forethought to prepare for it. There was organization out there to handle the job, the Washington part of it was organized, the plants were cleared as fast as we could get them through, and the whole thing functioned from the start. Maybe if we had to do it over again we could do it perhaps a little quicker, but in all modesty I think we ought to be agreed that the job was done, and done well—and splendidly. (Applause.)

NOW I have been out looking at plants during the last three months. I have seen a lot of them. I have talked to a lot of manufacturers. I have even talked to a lot of men, and I have talked to a lot of General Wesson's officers, and it naturally comes home to you—it can't help but come home to you—that all this work that has been done out there was helped enormously by the work that was done in the arsenals previous to the start of this program. The very ingenious way of placing each arsenal on a specific line of ord-

nance material and carrying that development along made it possible to transfer these processes out to other factories practically *in toto* and get into production very quickly. I can't help but smile and feel proud—giving the entire credit to the Ordnance Department—when I see all these small-arms and ammunition plants pumping away at caliber .30 and caliber .50 ammunition conceived in the Frankford Arsenal, born in the Frankford Arsenal, and propagated out into the rest of the United States. (Applause.)

The same thing applies to guns—little guns and big guns. The same thing applies to tanks and to shells, and it is really a revelation to see how forethought, enthusiasm, and belief in the product has made it possible for the whole country to get busy. (Applause.)

And also I might say that I have been in every arsenal but one—I have been in every arsenal in the United States but one, and there is production going on now; and I am going to tell you gentlemen that are competing with them, or trying to work alongside of them, that you'd better look to your laurels, because some of them are doing awfully well! In some of the arsenals you can see a pretty good example of mass production. (Applause.)

Now when you go out and see all these things, you talk with a lot of people—and I have talked with a lot—and from practically every one that I talked with, if the talk came around to General Wesson, were heard the finest expressions of affection and respect. When I hear that, I know General Wesson must have within him the qualities that earn it; otherwise he wouldn't get it. (Applause.)

General Wesson, as a coworker in fifty per cent of your career (laughter) I want to extend my sincere well wishes, my sincere respect and regard for what you have done, and my hope that you will live many years and enjoy the fruits thereof! Thank you very much. (The audience arose and applauded.)

THE TOASTMASTER: Thank you, General Knudsen. We all share your expression of gratitude to General Wesson, and, needless to say, we all approve most heartily the well-deserved and moving tribute that you have paid to him.

Gentlemen, there is one man in the United States who knows the industrial phases of modern warfare as no one else knows them. It was he who carried our industrial effort in the World War to such great heights. During every year since then he has been the leader of thought and of action in directing our plan for industrial mobilization in time of war. We are most fortunate in having him with us tonight, and we have asked him to speak on this program in tribute to General Wesson's work for the Ordnance Department of the Army, and particularly in the light of the economics of armament production for victory. It is my pleasure to introduce to you now a business man, an economist of the highest rank, the World War chairman of the War Industries Board, and the leader of our soundest thinking on the economics of warfare. I give you Mr. Bernard M. Baruch. (The audience arose and applauded.)

Address of Mr. Bernard M. Baruch

MR. BARUCH: Mr. Toastmaster, gentlemen. What I am about to say will not be an address, but, rather, a few kind words about a body of men who so justly deserve them.

My friends in the Ordnance Corps, I am glad to be here tonight as evidence of the interest in and affection for the Corps that I have held for twenty-five years. I saw your work in the last war and in this. Therefore I speak with authority in my eulogies.

When your outfit, through the War College and then through the Industrial College, began to study the major aspects of modern war, few military men knew what you were talking about. You were fitting your plans into the pattern of total war, of what we then called "a nation in arms." Your studies, your efforts, were persisted in, even though you were pushed aside. You saw your job to be the defense of our country, and, by God, nothing could switch you from that purpose! (Applause.)

Now the light is dawning, and the scoffers begin to see you as the pioneers in a field unknown and therefore ignored. But indifference and derision were but goads to spur you on. You are coming into your own. I do not mean recognition of the public—it is enough for you to have the approval of your conscience; I mean in seeing the job done, each day adding to the work of the day before, work that could not have been done except for your magnificent pertinacity, intelligence, and skill.

While we prayed to God, you plied the hammer. You let nothing stop you. Thank God for your dauntless courage!

I have been familiar with your disappointments. I have seen the Corps characterized as international Dillingers. I have seen officers unable to defend themselves against the grossest insults and most unfounded charges. I have continuously seen disregarded the recommendations of your Chiefs of Staff, of your Assistant Secretaries of War and their colleagues in the Army, regarding organization, powder, ammunition, airplanes, strategic materials, and machine tools, which, if they had been followed, would have placed this country in a different position than that in which we found ourselves at the outbreak of war. (Applause.)

But thanks to the courage and foresight in continuing your studies, even though you did not receive support, the Army was not found wanting. (Applause.)

I was a friend of the Ordnance Chiefs in the last war, when we were fortunate to have the advice and assistance of men like General Crozier and General Williams (applause), under the guidance of Benedict Crowell (applause), who deserved a sword of honor from the Congress for his driving, efficient work. He was Assistant Secretary of War to a great man, Newton Baker (applause), who held place under the immortal Woodrow Wilson (applause).

I WANT to say something about the Ordnance Department as I have seen it develop. The Navy has always been the darling of the Government. (Laughter and applause.) When war was thrust upon us before, as now, Ordnance had to meet unprecedented demands, astronomical in their proportions, and everybody expected them to be met overnight. Facilities had to be enlarged to produce not alone for ourselves but for the whole world fighting against Germany, Italy, and now Japan.

What the Ordnance Department has done under General Wesson is almost a miracle. I know that you have not done all that you would have liked to do, General Wesson, but through association with you and your work I have learned to have the highest regard for you and your fellows (applause) and for what you accomplished under most trying circumstances and under floods of criticism. I do not wish in any way to reflect upon the other branches of the services, who also have performed incredibly. I know more of the heartbreaking efforts of the Ordnance and against what it

had to contend. I learned to respect your intelligence, General Wesson, your wisdom, your capacity, your courage, and your bulldog tenacity. (Applause.)

My admiration goes also to that selfless, Cromwellian, able, courageous, efficient Robert Patterson, Under Secretary of War (applause), and his Chief, Mr. Secretary Stimson (applause), and his associates McCoy (applause) and Lovett (applause), and to Lieutenant General Knudsen (applause).

Now "The Campbell is coming, hurrah, hurrah!" (Laughter and applause.) I know he will carry on in the best traditions of the Ordnance Department for the accomplishment of the seemingly impossible. (Cheers.) I feel impelled also to mention the telling efforts of men like General Harris (applause) and General Lewis (applause), and the long roster of others.

I join with this Association, headed by my distinguished and able coworker, General Crowell, in saying that you, General Wesson, and your organization have helped greatly in the war program. For that our people owe you much.

"Well done!" is the tribute America pays you. It is deeply deserved. (Applause.)

THE TOASTMASTER: Thank you very much, Mr. Baruch. You, too, have expressed sentiments, not only about our guest of honor but about the progress of our own efforts, in which we all concur, and we are therefore doubly grateful to you for your message.

Next on our program is the officer who will succeed General Wesson as Chief of Ordnance of the United States Army. (Cheers and applause.) He is well known to many of you for the outstanding work he has done in many fields of Ordnance activity over many years. His most recent achievement was the handling of the vast Ordnance program of new facilities, and more recently he has been in charge of production for the entire Ordnance Department. He is a man of action, whom we are all pleased to welcome here tonight. I present to you our next Chief of Ordnance, Maj. Gen. Levin H. Campbell, Jr., who will speak to us on behalf of the Ordnance Department. General Campbell. (The audience arose, applauded, and cheered.)

Address of Maj. Gen. Levin H. Campbell, Jr.

GENERAL CAMPBELL: Mr. Chairman, General Wesson, and gentlemen. I stand here tonight and I am very, very proud to feel that I, of those who have labored in the vineyard with General Wesson, am permitted to speak on behalf of the officers and civilian employees of that great institution, the Ordnance Department. (Applause.) And if you will believe me, I stand here also in very great humility, because I am following a man! (Applause.)

I have a job ahead of me, and I have to do it. We in the Ordnance Department are a big institution—we think big, and we act big. We have had a big leader, and a man of whom I'd like to tell you something from the human side, as we down in the bottom of the ranks know him.

If I had to describe him in one word, I would say that he is a leader. (Applause.) The respect that we all hold in our hearts for you, General Wesson, you have deserved, you have won, and you have worked for. I have often noticed, in the last two years, when I have been by your side, the hours that you have put in—one of the first at the office in the morning; one of the last to leave at night—and I venture to say that even though you retire, Sunday night you will be working until 12 o'clock midnight. That is your nature, and that is what has made us feel that there is nothing in the world that you will not do that you would ask us to do. That is a leader! (Applause.)

Now there is another side to this man whom we honor tonight. All the kids like him! (Laughter.) And that means a great deal. My daughter asked me last night where I was going tonight, and I told her, up here to do honor to General Wesson, and she said, "I remember him so well in London, when I was 12. The General had an opera hat, and he used to snap it like that, and it would jump like that"—and this little Virginia of mine followed him around London in admiration. When Mrs. Wesson asked us down to dinner, my little daughter said, "Daddy, is the King going to be there?" (Laughter.) This is the man that we love. This is the man who gives us hell, next pats us on the back, and is fair above all.

Gentlemen, war is a cruel thing, it is a hard thing, and you have to be tough to fight it, whether it is at the front or whether it is at a desk. I pledge above all that I am going to be fair, I am going to do this job as I see it, and with the help of the fellow officers in the Ordnance Department we will not fail! (Applause.)

General Wesson, you have builded a foundation, and you have turned it over to me. I will not fail you. The foundation is solid; the policies which you have set up for us will not be changed one iota. (Applause.) Those policies which have been carried out by such men as my very, very good friends, General Harris, General McFarland, and General Crain will be carried forward to a successful conclusion. (Applause.) We are going to win; we can't lose! (Applause.)

And so, General Wesson, you are leaving us, but you and I, I am glad to say, have a little understanding on the side, and I am looking forward to it because I know you won't be far away, and that makes me feel pretty safe, boys! (Laughter and applause.)

Let me say to you now, as we used to say in Spain: "Vaya con Dios"—May God go with you! (The audience arose and applauded.)

THE TOASTMASTER: General Campbell, in conveying the thanks of all present for your most inspiring and eloquent message, may I also extend to you, on behalf of all of us, our sincerest good wishes for a successful tour of duty as Chief of Ordnance. (Applause.) You have inherited a truly great organization, and I can assure you that all of us who are a part of it in military life and in industrial life stand ready to give you the same fine coöperation which has been so apparent on all sides during General Wesson's term. (Applause.)

And now, gentlemen, we are honored by the presence of the Under Secretary of War. (Applause.) He is the boss of our guest of honor, and when the boss, in the midst of a great war effort, leaves his official duties to attend a function of this kind, to speak of the achievements of one of his staff, that in itself is tribute indeed. Judge Patterson is well known to many of us for his great judicial work here in New York. As the Under Secretary of War, he has been faced with problems of the greatest moment. His fearless and effective handling of his duties has brought to him the highest encomiums. I am pleased to introduce to you the Under Secretary of War, the Hon. Robert P. Patterson. (The audience arose and applauded.)

Address of the Hon. Robert P. Patterson

MR. PATTERSON: Mr. Chairman, officers of the Ordnance Department, members of the Army Ordnance Association, and friends. Tonight many old friends are gathered

to pay tribute to a great soldier. I am honored, indeed, to be included among his friends. It has been my privilege to be closely associated with him for the past two years, and it is a great pleasure for me to pay tribute to the outstanding work that he has done.

FOR nearly half a century, General Wesson has served his country faithfully. He has the esteem of the Army and of the people of this country—the men in the ranks, the workers in the arsenals, the men of industry—and he has that esteem because he has earned it. It was his lot to be Chief of Ordnance during the most difficult time in this country's history, and it was our good fortune. He was chosen for this all-important position in 1938. He had seen this thing coming, and he was prepared for it. He was foresighted, he was shrewd, he was modern-minded, and he knew how to get things done. Above all, he was preëminent in leadership.

When he was a cadet at West Point, he gave evidence of these qualities of leadership: Here is what he did in the Army and Navy game—and I am reading from the *New York Sun* of December 3, 1899 (I was eight years old!):

"Wesson played a magnificent game. Fleet of foot, he was faster than the two Navy ends, Long and Berrien, whom he dodged several times during the game. As a quarterback, Wesson was a star. He handled Wade's punts without a muff and made pretty runs in broken field. Wesson's tackling was a feature, too, and, though knocked out frequently because of his constant presence in line-bucking plays, he stuck it out with remarkable gameness." (Applause.)

We all know him, and we all know that he has not lost, in the intervening forty-three years, that quality of gameness. (Applause.)

When he became Chief of Ordnance, people felt that war was a thing of the past for us in America. It was then that General Wesson and his colleagues were preparing for the inevitable future. He sponsored the Garand rifle and fought hard until it was adopted by all our armed forces. (Applause.) I might add that I fought also for the Garand rifle, not out of any feeling that I knew rifles, but because I was sure that General Wesson was bound to be right! (Applause.) And his faith was vindicated when General MacArthur reported that the Garand had proved its superiority in the Philippines under the most arduous battle conditions. (Applause.)

When Europe was overrun by the Nazis two years ago, people still said it couldn't happen here. The President warned us of the approaching storm and of what might be in store for us. His call for 50,000 planes, you will remember, seemed a fantastic impossibility to many, but this year's production of planes by American industry will surpass the 50,000 figure by a healthy margin! (Applause.)

The Nazis announced to the world that the British Army had been used up in Flanders. The British Army was not used up. It turned up in England a few weeks later, but it needed weapons to carry on the fight. The President gave the order to scour the arsenals for these weapons, and it was General Wesson who carried out that order. (Applause.)

I do not need to remind any one here of the obstacles that have been overcome in these two years since Dunkerque. On December 29, 1940, the President said: "American industrial genius, unmatched throughout the world in the solution of production problems, has been called upon to bring its resources and its talents into action. Manufacturers of watches and of farm implements, of linotypes, cash registers and automobiles, and of sewing machines and lawnmowers and locomotives are now making fuzes, bomb packing crates, telescope mounts, shells, pistols, and tanks."

Now we can look back with pride at the job that American industry has done. This was possible because the officers of the Regular Army planned while others slept. When the signal was given to go forward, they were prepared. Years of careful planning enabled them to swing into action at full speed. Under General Wesson's vigorous leadership, immediate action was taken. Steps were taken to stock up the Arsenal of Democracy.

It is no accident—this tremendous achievement of the Ordnance Department. At the conclusion of the First World War, a handful of officers sat down, analyzed the records, took account of their successes and their failures, and began to plan for the next emergency. They knew that war would inevitably come to America again. They knew that when this happened we would have to depend upon our own resources. So they went to work, back there in the 1920's—back in those peaceful, prosperous, indifferent 1920's when no one cared about defense—back in the 1930's when we still felt that war for America was in the past tense.

They sent officers out to inspect America's productive capacity. They labeled individual plants for war production. By persuasion and not by law they surveyed America against the chance of war when no war clouds were on the horizon. So when the crisis came, the Ordnance Department was ready.

They had saved a little money from microscopic appropriations to buy bits of machinery to lay aside for M-day. When the expansion program was announced, the Ordnance Department pulled out of storage in its arsenals machines which would have taken years to build, and the program was under way.

For years the Ordnance Department urged additional orders for the training of industry for its war-time tasks. The pleas went unheeded—until just before the crisis. But the few companies that had been given educational orders justified the vision of the Ordnance Department. They were ready to take on the grave responsibilities of war production.

ORDNANCE items are not on sale in the market. Sites for new plants had to be found, and the plants had to be built. Machine tools had to be procured and workers trained before production could begin. Patiently and efficiently, the Ordnance Department carried out this arduous task. It took the job in stride, including the criticism that went with it. While the needs of the sea and air took their rightful priorities in production, the Ordnance Department had to go along, improvising and plugging away, while an impatient people clamored for more tanks, more guns, more powder.

They did not realize that it takes time to make these weapons. First you count them in tens, then in hundreds. But after the tanks and the guns and the powder finally start moving, they keep rolling and rolling along. We are no longer counting our tanks by the tens or by the hundreds, but by the thousands. (Applause.) We measure our weekly production of ammunition in hundreds of *millions* of rounds. We are gathering the fruit of the years of work and pioneering in the past, thanks to the unflagging zeal of General Wesson, General Harris, and the other Ordnance leaders (applause), and thanks also to the matchless contributions given in the past two years by General Knudsen. (Applause.)

These leaders have created a modern and effective system of procurement and production. They have built up the Ordnance districts as the backbone of the production program. I assure you that they have an organization capable of handling the huge responsibilities placed upon them. They will not fail the men on the firing line. The gigantic business which they are running today exceeds in size any business that we have ever undertaken. The cost of the present Ordnance program is over twenty billions. Two years ago we were getting deliveries of Ordnance material at the rate of one million dollars' worth a month. Last month the deliveries of Ordnance material came to 458 times that figure of two years ago. (Applause.)

And we are getting our money's worth. Tank for tank and gun for gun, the weapons developed and produced by the Ordnance Department have taken their place on the world's battle fronts and are holding their own against the best that the Nazis and the Japanese can produce.

The War Department is proud of General Wesson's achievements. He is now turning over the leadership of this vast undertaking to an able and experienced successor, Maj. Gen. Levin H. Campbell, Jr. General Campbell takes over a job well under way. It is not handicapped by the curse of too little and too late. (Applause.) He is the beneficiary of General Wesson's slogan, "Enough and on time."

When the history of the Second World War is written, the names of the Army and Navy officers who armed the country will be set down in the roll of victory. They, along with the workers and industrialists who carried out their plans, will be credited with winning the war of production. And among the first names will be that of the illustrious officer we honor tonight, Maj. Gen. Charles M. Wesson.

AND now may I read a letter from the Secretary of War to General Wesson. I am the mailman who is going to deliver it as soon as I have read it:

Dear General Wesson:

On the conclusion of your 4-year term as Chief of Ordnance, I wish to express my personal commendation and that of the War Department on the manner in which you have performed your heavy task. To you fell the responsibility of directing our tremendous wartime Ordnance program, a program unequaled in size by anything in our history. From a small organization in 1938, when you became Chief of Ordnance, you have built the splendid machinery capable of handling our program of tens of billions of dollars of ordnance matériel. You have performed your duties with skill, vision, and energy, and have earned the respect and admiration of fellow officers and men and the gratitude of the country.

The years of preparation of the Ordnance Department are now bearing fruit, and labor and industry of this country have now been mobilized on a vast scale to produce more and better weapons and ammunition than the world has ever seen. As a result of your leadership, the Ordnance Department is today going forward successfully with its mission of supplying munitions in ever-increasing quantities to our own troops and those of the United Nations.

Sincerely yours,

HENRY L. STIMSON.

And now I come to the crowning mercy of them all! It is with great pleasure that I now give to General Wesson the oak-leaf cluster of the Distinguished Service Medal. (The audience arose and applauded during this presentation.) I presume you all know the significance of that. The oak-leaf cluster is awarded to a man who already has the Distinguished Service Medal. It is an encore—a second award. And the citation that goes with this award is this:

"Charles M. Wesson, Major General, Chief of Ordnance, United States Army. For exceptionally meritorious and distinguished service in a position of great responsibility. As Chief of Ordnance, United States Army, from June 3, 1938, to May 31, 1942, Major General Charles M. Wesson was charged with the expansion of the Ordnance Department and the conduct of the greatest ordnance program of all time. In this position, General Wesson demonstrated rare technical knowledge, drive, and good judgment, and handled the work of the Department with such skill and boldness as to contribute greatly to the success of not only the war efforts of the United States but those of the United Nations." (Applause.)

THE TOASTMASTER: Mr. Secretary, we are very grateful to you for choosing this occasion to present the important and richly deserved decoration to General Wesson. We are also very grateful to you for your address, and we assure you that you have expressed sentiments which are shared by all of us.

Tribute to Maj. Gen. Charles T. Harris, Jr.

WE now come to a portion of our program wherein the Army Ordnance Association will confer its highest award upon our guest of honor. Presently I will call upon the president of the Army Ordnance Association, who will read the citation which accompanies the award, but before doing that may I take the liberty of introducing to you, so that you may all join me in a well-rounded tribute of applause, the man who has stood at General Wesson's right hand for the past four years, and upon whose shoulders the great Ordnance program has rested squarely. He has borne that heavy responsibility with characteristic success, and I feel that you all join with me in saying to him, through our applause, that we are grateful to him for his fine work, and we congratulate him for it. I am going to ask Maj. Gen. Charles T. Harris, Jr., Chief of the Industrial Service of the Ordnance Department, to stand and receive our tribute. (Applause.)

VOICES: Speech! Speech! Speech! (General Harris arose, smiled, waved a friendly greeting to the audience, and then resumed his seat.)

THE TOASTMASTER: I now call upon the president of the Army Ordnance Association, Brig. Gen. Benedict Crowell, to read the citation which accompanies the award to General Wesson. General Crowell. (Applause.)

Award of the Williams Gold Medal to General Wesson

GENERAL CROWELL: On behalf of the Board of Directors of the Army Ordnance Association, I wish to announce that the Association confers upon Major General Wesson, Chief of Ordnance, the highest award within its power to grant, the Williams Gold Medal for Distinguished Ordnance Service. We are fortunate to have with us Maj. Gen. C. C. Williams, Chief of Ordnance from 1918 to 1930 (applause), for whom this medal was named. During the twenty-three years of the Army Ordnance Association's history, the medal

has been awarded to only one other recipient—General Williams himself. I am going to ask General Williams to confer the medal upon General Wesson after I have read the following citation: (Applause and cheers.)

"During the past four years, our country and military armament have passed through three distinct stages. The first was a period of preparation for armament production. Next came the lengthier period during which production was undertaken on a scale hitherto unknown to the American people. And finally, with the attainment of maximum production in many types of military armament, came the Japanese attack upon Pearl Harbor and war.

"To have led the forces of armament research, production, and logistics during these momentous years, and to have led them with the degree of success which has merited the approval of engineers, industrialists, and soldiers everywhere, is an achievement which deserves highest honor.

"Major General Charles Macon Wesson, Chief of Ordnance, 1938-1942, has performed this great task in a highly commendable manner. Soldier, administrator, he has adhered faithfully to the time-proved plan of industrial mobilization which the Ordnance forces have developed during the past twenty years.

"He has been a leader in upholding the Ordnance district system of decentralized procurement. He has encouraged the development and use of the Ordnance arsenals and manufacturing facilities to the greatest possible degree. He has led the vast forces which comprise the Ordnance Department of the Army and the Ordnance forces of industry with wisdom, prudence, and energy.

"Therefore the Army Ordnance Association, by the unanimous act of its Board of Directors, acclaims General Wesson for his great contribution to ultimate victory for the armed forces of the United States and of the United Nations, and in recognition of his services as Chief of Ordnance of the Army of the United States confers upon him the Williams Gold Medal for Distinguished Ordnance Service."

I will ask General Williams to confer this award. (During the presentation the audience arose and applauded.)

GENERAL WILLIAMS: It gives me great pleasure to present this to you, General Wesson, my friend.

Address of Maj. Gen. C. M. Wesson

GENERAL WESSON: Mr. Toastmaster, Mr. Secretary, distinguished guests, comrades, fellow workers, and friends. I am sure that none of you could have expected me adequately to portray in words the great emotions which fill my breast! I have been honored here tonight far beyond my wildest hopes or most fantastic dreams. It should be remembered, however, that in anything that I may have done for our country I have been but one member of a team (applause), and the honors which have befallen me belong equally to all those with whom I have worked.

I have taken a long journey, and it has not been uneventful. It has led me sometimes far afield, and it has brought me in contact with the most outstanding and transcending events of my period. Obstacles have been met which had to be overcome or circumvented. The journey has not been without its disappointments and discouragements, but it has been replete with the joy of working and doing things. (Applause.)

The journey, gentlemen, has been well worth taking. Almost every man in the vast throng which fills this great hall is a member of the team to which our armies look to supply them with the best equipment—not only the best equipment, but enough and on time. To distribute and maintain this equipment so that its full power may be brought to crush our enemies, this team comprises thousands of members. In it are represented both the small and the great in the Army and industry, from those who direct to the thousands who, by their toil and sweat, play their vital part.

This team, I believe, knows what it is up against. This team, I believe, is inspired by the responsibilities which rest upon it, and I believe that it is doing one of the greatest jobs of all time. From the sidelines, with unflagging interest, I shall watch its every play with the utmost confidence that when the whistle blows each and every member will have a just pride in the common victory. Thank you. (The audience arose and applauded.)

THE TOASTMASTER: General Wesson, I know I am speaking the mind of every one in this room when I say that your inspiring address is a fitting climax to this occasion.

And, gentlemen, this concludes our meeting; and may I thank you again for your attendance; and may I again congratulate our guest of honor; and finally may I pledge to General Campbell, our new Chief of Ordnance, the unfailing and unfaltering coöperation of all of us in every enterprise of the Ordnance Department, to the end that Victory, complete and total, may, in the providence of God, come to us and our allies most speedily. I bid you all good night. (Whereupon the meeting adjourned.)

EDITOR'S NOTE.—Present at the testimonial dinner were not only the leaders of the armament effort high in the War Department and the Army but also the leaders of American industry. Never has a more representative gathering of industrial power been assembled for such a function. Here again industry's tribute to Army Ordnance and Army Ordnance's tribute to industry were significant of the joint effort which has characterized the Ordnance endeavor for many years past. What was said by industry in praise of the Ordnance effort can be taken by every member of the Ordnance team as applicable individually. Thus, many of the officers who bore heavy responsibilities during General Wesson's régime share notably in the achievement. So also do the leaders of labor and management who have toiled unremittingly since the first days of the accelerated Ordnance production program in 1938.

In Mr. Keller's remarks published on page 74, reference is made to the address given by General Wesson before the Newcomen Society of England at the University Club, New York City, on April 23, 1942. This address was delivered before a distinguished gathering at which Dr. Charles Penrose of Philadelphia, senior vice-president of Newcomen for North America, presided, and Lieut. Gen. Hugh A. Drum, commanding general of the First Army, introduced the guest of honor. The address, entitled, "Ordnance in My Time," was published in full as the leading article of the preceding issue of this journal (ARMY ORDNANCE, May-June 1942, Vol. XXII, No. 132, p. 927).

The Wesson dinner thus stands as a record of the case during the first four years of America's greatest Ordnance effort. It was the Under Secretary of War, Hon. Robert P. Patterson, who cited the motto of that period—"Enough and On Time." This is a record of which all the American people can be proud. It foreshadows a greater responsibility in which every member of the Ordnance team from now on has an even larger share in bringing ultimate Victory.

Signal Corps

MAJ. GEN. LEVIN H. CAMPBELL, JR.
Chief of Ordnance, United States Army,
whose 4-year term of office began June 1, 1942.

Arms Manufacture in India

Modern Methods Speed Production in an Ancient Bastion

S. J. Hopper *

TOWARD the end of the eighteenth century, the East India Company, which hitherto had been merely a trading corporation, became, by its acquisition of Bengal, Orissa, and Northern Madras, a territorial power of considerable magnitude and importance. The growth of this power aroused considerable uneasiness among the neighboring native states and led to the famous alliance of Hyderbad, Mysore, and Mahrattas, which, with the help of the French, seriously threatened the maintenance of British power in the East. These and wars nearer home, together with overseas expeditions, threw an exceptionally heavy strain on the ordnance manufacturing establishments in the Bengal Presidency.

The arsenal, the gun foundry and the gun carriage plant were all confined within the narrow limits of Fort William at Calcutta, and, as expansion in the fort was impracticable, it was decided in 1798 to remove the agency responsible for gun carriages to Kidderpore. This location was soon found inadequate, and in 1801 negotiations were entered into to purchase for 20,000 rupees (about $6,600) a house and land at Cossipore, about 5 miles from Calcutta on the banks of the River Hooghly. It might be of interest, inasmuch as we are discussing land purchase, to show how the value of land has appreciated in the neighborhood of Calcutta: land bought in 1801 for $2,000, in 1909 was worth $60,000.

The Cossipore Agency, as it used to be called—now known as the Gun and Shell Factory—was established for the purpose of supplying gun carriages to the Bengal Army and the supply of half-wrought timber to other establishments. Timber was quite a factor in gun-carriage building at that time. It was thought that timber seasoned better in the lower Bengal climate than in the drier climates of upper India. This idea has been radically changed however, although a trace of it is still to be found in the prevalent practice of leaving a log to season in its own jungles for a year after felling.

As soon as the purchase of land had been effected, the executive engineer at Fort William was instructed to estimate for the necessary buildings, which estimate amounted to 20,000 rupees, or about $6,600, as was mentioned above. The land was purchased, and buildings were planned, sanctioned, and erected in less than six months, which, considering the climate and the native labor, was an excellent performance. None of the original buildings are now in existence. The only one of the really old buildings still in operation is one erected in 1831 for turning and boring guns.

We find that on March 18, 1802, the Military Board submitted a final survey report on the completed "Gun Carriage Agency Yard," and work in it apparently commenced about the same time under a Lieutenant Colonel Glass.

To show the excessive centralization of business 130 years ago, we find that the governor-general in council authorized the purchase of two sentry boxes and a capstan in 1804. No governor-general in this day and age would be bothered with such petty details; however, that was the method of doing business then.

From 1801 to 1814, there apparently was a type of contract system in vogue in which the superintendent or agent participated at considerable profit to himself. In 1814 it was decided to abolish this system, much to the agent's disgust. He complained bitterly of the cost of living at Cossipore and that he had to pay 250 rupees for rent (about $80 a month). The emoluments at that time, however, were very acceptable compared to present-day standards. A first lieutenant received about $500 a month and a captain about $575. The agent in 1836 pointed out that he was responsible for thirty-five lathes and two steam engines totaling twenty-two horsepower and that his pay was very inadequate for such tremendous responsibilities. His representations were successful, and in 1837 he was granted an increase of $100 a month.

WE find that in 1815, first reference was made to utilizing iron ore and making bar iron and ordnance chain from what was called bundekhand. To show the extent that the smithy entered into ordnance at that time, in 1820 there were fifty-nine forges at Cossipore.

Up to 1830, guns were still being cast at Fort William, although the actual manufacturing and carriage building was being carried out at Cossipore, but during this year it was decided that the space available at the fort was insufficient, and it was decided to transfer this work also to Cossipore. The new foundry at Cossipore was completed in 1834, the machinery consisting of 2 steam engines of 10 and 12 horsepower respectively, 6 gun lathes, a trunnion lathe, 5 additional lathes brought from the old foundry with 2 small lathes and 2 screw-cutting lathes, in addition to those already used, making a total of some 50 lathes. Naturally, there were manufacturing difficulties to be overcome, but we find that Cossipore-built guns did excellent service in the Afghan, Scind, and Sikh campaigns as well as in the Indian Sepoy Mutiny.

From 1840 to 1850 the output of guns and shells was quite large, and during these years considerable progress was made in tabulating and developing the uses of war material and preparing range tables. The following matériel manufactured during this period will, no doubt, be of interest:

Iron Guns	*Brass Guns*	*Iron Howitzers*	*Brass Howitzers*
32-pdr.	9-pdr.	10-inch	24-pdr.
24-pdr.	6-pdr.	8-inch (5 lbs.)	12-pdr.
18-pdr.	3-pdr.	8-inch (4 lbs.)	12-pdr. (mountain train)
12-pdr.			

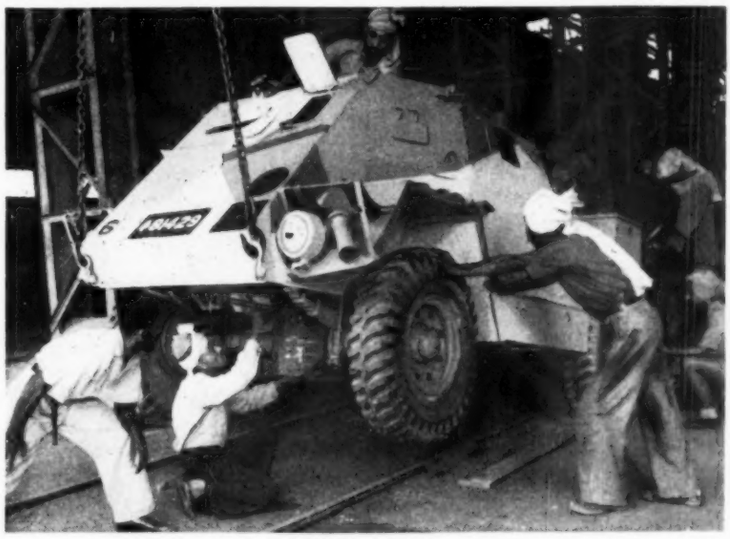
(8-, 10-, and 13-inch iron mortars and 4 2/5-inch and 5½-inch brass mortars also were manufactured.)

A list of shot and shell was equally diversified. Thus we find that common and spherical shell were made as well as round and case shot for all types of ordnance. An incendiary shell also was made, with ordinary and common shell being filled with stars of "valenciennes" composition. The proof reports show the progress of manufacture: In June 1853, no less than ninety-two iron guns passed proof, and in Decem-

*Former superintendent of the Gun and Shell Factory, Cossipore, India, and of the Metal and Steel Factory, Ishapore, India.

ber of the same year seventeen brass mountain train howitzers were accepted.

Cossipore also manufactured all the cast-iron garrison carriages required. This was about the year of the Indian Sepoy Mutiny, and it would be well to mention that this mutiny was essentially confined to parts of the army, while the rest of the army and the great mass of the Indian population remained entirely peaceful. The last survivor of the native supervisors who were successful in getting the men into work at that time, one Sheik Arman, retired in 1906 on a pension after a service of nearly sixty years.



AN ARMORED CAR BEING COMPLETED AT AN INDIAN RAILWAY SHOP

IN 1860 the question of rifled ordnance and of elongated projectiles was being much discussed, and the former does not appear to have found great favor. Thus we find a select committee reporting with reference to the equipment of the mountain train with an Armstrong 3-pounder rifled gun that "after all, a rifled gun was only a rifle," and going on to say that as there would always be infantry in support, such a gun would be less effective than the escort. On the other hand, the principle of the elongated projectile was liked by all, and many experiments were carried out in this direction.

It finally was decided to import a complete plant for rifling smoothbore guns in the service. The attempt to use smoothbore ordnance for this purpose was a failure, the brass being too soft to withstand the high pressures entailed with rifled ordnance. About the same time, the introduction of iron ordnance in England rendered any further question of using bronze guns unnecessary. India could not afford to lag behind, and relegated all existing types—types which had remained practically unchanged for the greater part of a century—to the scrap heap. However, it was felt that the time was hardly ripe in India for extensive working in such a new and uncertain material as steel, and, as a result, gun manufacturing came to an end for a time, and all types of guns were imported.

In 1887, the demands of munition requirements had outgrown the capacity of Cossipore, and a part of it was removed to a site at Ishapore, about seventeen miles from Calcutta, also on the banks of the Hooghly. Machinery was imported for rolling the metal for the manufacture of cartridges, and in 1909 the output reached 3,000 tons of rolled brass, cupronickel, and copper. In 1892, the manufacture of steel was begun and, after almost insuperable difficulties, finally established. In 1896, this portion of the factory was further supplemented by a rolling mill from which a large variety of steels was turned out for the Indian Marine, the Public Works Department (especially railways), military works, and, of course, for the Ordnance factories and arsenals.

In 1903, it was decided to move the steel and iron furnaces, the bar mill, and the cartridge-metal plant to Ishapore, which was sufficiently far advanced in 1906 to start the manufacture of brass, copper, cupronickel ingot and strip, and of steel bar.

In 1905, the manufacture of quick-firing guns for horse and field artillery was introduced, and a plant suitable for the manufacture of from ninety to one hundred guns annually was set up. In 1909, the cost of manufacture of such a gun in England was $1,850, whereas the same gun could be made in India for $1,400, and as the former amount did not include freight, the financial results obtained by manufacturing in India were very gratifying.

APPARENTLY every attempt was made by the powers in India to keep abreast of the times, and in 1910 the old steam-driven equipment was replaced with electric power throughout. At Cossipore there are four 200-kilowatt and two 50-kilowatt steam sets and the necessary boilers for power and steam hammers, etc. At Ishapore there are four 200-kilowatt sets and twenty Lancashire boilers, as well as hydraulic pumps for shell forging and extrusion presses. There are also gas producers to generate gas for the open-hearth plant and all furnaces which are gas-fired.

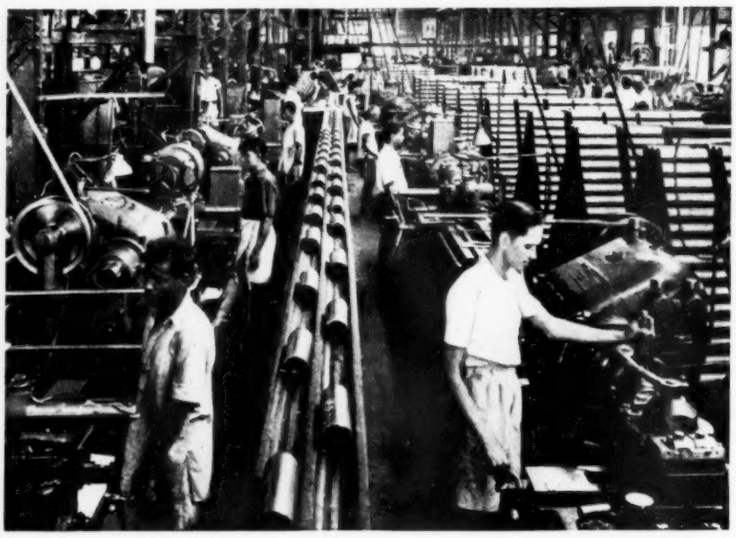
During the First World War, extensive additions were made to both these factories, and the most modern equipment was installed for the production of shells, fuzes, cartridge cases, and gages which would have done justice to any modern American factory. These two factories are now almost self-sufficient; until recently, heavy gun forgings were beyond the capacity of the steam-hammer equipment at Ishapore. Among their manufactures may be noted quick-firing guns for horse and field artillery, mountain guns which are made from indigenous materials, shells of all calibers, gun fittings of all sorts from Indian steel, cups for .303 rifle ammunition and also for revolver ammunition, 18-pounder and 13-pounder shells, quick-firing cartridge cases, steel bar and rod, steel and iron castings, heliographs and signaling lamps, besides work of a general engineering nature and many of the miscellaneous items required by an army.

The Indian Ordnance organization before the present war consisted, in addition to these two factories (known as the Gun and Shell Factory, Cossipore, and the Metal and Steel Factory, Ishapore), of a rifle factory at Ishapore where, as its name implies, rifles are manufactured. Some ten miles from Calcutta at Dumdum (the name given to the world-famous bullet, and where it is alleged the Indian Sepoy Mutiny was fomented), there is an explosives and filling factory. At Jubbelpore, some one hundred miles from Calcutta

in the Central Provinces, complete gun carriages are fabricated, most of the steel being furnished from Ishapore.

In the Madras Presidency at a place called Aravankadu, there is a cordite factory, and in the Bombay Presidency at a place called Kirkee there is a filling factory where the small-arms ammunition cups made at Ishapore are completed and filled.

THE planning and launching of a large number of new projects for the expansion and modernization of ordnance factories, the further development of existing schemes, the establishment of an aircraft factory, the revival of the shipbuilding industry, and an all around expansion in the range and output of arms and ammunition—these have been some of India's achievements in the field of munitions production during the second year of the present war.



AN INDIAN RAILWAY SHOP CONVERTED TO SHELL PRODUCTION

Outside the established ordnance factories, the main potential for the production of munitions is in railway workshops. The engineering industry in India is generally on a jobbing basis and exists mainly to maintain other industries and not for production in the accepted sense.

When war broke out, India was engaged on a plan recommended by the Chatfield Committee for the expansion and modernization of the existing ordnance factories and the establishment of additional factories for the manufacture of high explosives. The plan, estimated to cost about $12,021,036, involved an expansion of the factories by about 20 per cent and the provision of new plant and machinery which would enable them to manufacture certain of the most modern types of arms and ammunition. The plan was to reach full production by the end of 1941, except for certain items which are expected to come into production during 1942. Shortly after the outbreak of war, further additions were made to the Chatfield Plan for a large expansion in the production of small-arms ammunition.

In the autumn of 1940, the Ministry of Supply mission visited India and, as a result of the mission's recommendations, over twenty new munitions projects are now in hand. The total cost of these projects, running to over $34,560,478, is being borne by the British Government.

In addition to important expansions of existing factories, these projects include the reconditioning of an old factory for the manufacture of antigas respirators, machine-gun tripods, and air bombs, and the establishment of several new factories for guns, shells, mortar bombs, fuzes, cartridge cases, small-arms ammunition, and scientific instruments. All the projects have already been launched and are going ahead rapidly. In some cases there are prospects of production being started in advance of schedule.

It has not been possible to take over the entire capacity of railway workshops, as essential needs of the railways have to be met—and this is particularly important in view of shipping difficulties. All railway workshops, however, are being used to full capacity after satisfying essential railway needs, having regard to the difficulties of a production program which involves the delivery of interconnected components and to the need for flexibility in handling railway demands.

Between 250 and 300 civilian workshops are also employed to the fullest practicable limit on the production of munitions. These auxiliary establishments have undertaken the production of nearly 700 different items involving the manufacture of over 20,000,000 individual articles. Among the important munitions items manufactured by them are empty shells, fuzes, mortar bombs, grenades, antitank mines, shot and oil cookers. All spare capacity in Government mints is being used, and one canal workshop has been taken over completely.

ALL the ordnance factories are working to maximum capacity. Work is carried on by two 10-hour or three 8-hour shifts for six days a week in all cases, and for continuous processes seven days a week are worked. Outside ordnance factories, all major workshops are working six days and sometimes seven days a week with two 10-hour shifts.

The provision of skilled and semiskilled labor for the production of munitions on the expanded scale required by the projects in hand presents a problem of some magnitude which is not rendered easier by the comparatively limited engineering industry in India. Responsibility for training is shared by Supply and Labor Departments.

Under the Supply Department's scheme, systematic training is given in ordnance factories to assistant works managers under training, apprentices, boy artisans, supervisor trainees, artisan trainees, skilled men under training to highly skilled standard, semiskilled men under training to skilled standard, and unskilled men under training to semiskilled standard. Prewar schemes were inadequate for expanded requirements, and proposals for an intensive training scheme were submitted to the British Government in the United Kingdom which has sanctioned an expenditure of nearly $736,298 on it. The scheme provides for the training of several thousand men under the different categories. Work on the scheme is being energetically pushed forward.

The extent to which the production of arms and ammunition has been, and is being, expanded as a result of these manifold developments cannot, of course, be divulged; but some idea of the progress already achieved may be had from a few broad outlines. By the middle of 1941, India was making about five times as many guns a year as were made in

peace time, and it is intended to multiply this production figure again by nearly eight. The output of filled shell by June 1941 was already twenty-four times the prewar output, and it is intended to raise this in two stages to ninety-six times. Again, by the middle of 1941, India, in addition to meeting her own needs, had sent overseas something like 600,000 filled shells and 150,000,000 rounds of small-arms ammunition.

THE production of the various ordnance factories and auxiliary establishments at present consist of—to name only some of the important products—various types and calibers of shell, small-arms ammunition, pyrotechnics, grenades, complete guns and gun carriages of various types, rifles and bayonets and light machine guns.

When all the projects in hand are completed, the production will be further extended to include several other types and calibers of shell, shot, shrapnel, mortar bombs and small-arms ammunition, more varieties of pyrotechnics, and increased quantities of complete guns and gun carriages, howitzers, antitank guns, rifles, and light machine guns.

ASSEMBLING GUN PLATFORMS IN AN INDIAN SHOP

In the manufacture of high explosives, India is now well on the way to attaining self-sufficiency. The production of pure toluene for nitration has been established at a newly erected benzol-toluene plant, while a nitric-acid plant recently installed at a high-explosives factory has successfully passed its acceptance test. The first unit of a sulphuric-acid concentration plant, manufactured in India, also has satisfactorily passed its trial. Further plants of this type have been ordered for the expansion of high-explosives production.

Plant scale trials for the manufacture of mineral jelly for cordite have been successfully completed. The product is said to meet all tests within the specification limits, with an improvement in certain respects. The production of mercury fulminate and kieselgurh for the manufacture of dynamite has been established, while the installation of plant for the manufacture of TNT is nearing completion. A recent development is the production of a new type of cordite which eliminates the use of imported ingredients. It has been decided that the future output of cordite for gun ammunition will be of this type.

An Indian company for the assembly and manufacture of aircraft in India was formed in 1940. The Government of India entered into a contract with this company, in December 1940, for the purchase of a number of military aircraft to be produced by it with material obtained from America and elsewhere. Early this year, the Government took up a large number of shares in the company and placed a further order for several other types of aircraft.

The first aircraft to be assembled in India, a Harlow trainer, was completed by the company in July 1941 and successfully performed its trial flights. It is an up-to-date type of aircraft, designed in America, and has the same characteristics as modern fighters and bombers. A further type of aircraft which has been successfully produced by the company is the Curtiss Hawk, a modern high-performance fighter, also of American design. Production of both these types of aircraft is going ahead.

The construction of these aircraft in India is an outstanding example of the establishment of an important new industry with the direct assistance of government. The success of the enterprise has been greatly furthered by American aid. Although at present the material used in these aircraft is largely imported, there is every reason to hope that in due course, with the further development of the engineering industry, it will be possible to manufacture most of the parts from indigenous raw materials and so become less dependent on foreign sources for the supplies needed in this vital program.

A program for the construction of a large number of naval vessels of various types was initiated at the end of 1940 on the recommendation of the Eastern Group Conference which had suggested the use of India's existing capacity for this purpose. It was realized that India already had considerable capacity for building hulls of self-propelled lighters and craft for inland water transport, that she could supply most of the steel and all the timber required, and that she had a considerable labor potential. She had, however, no capacity for manufacturing engines and boilers, and it would be necessary, therefore, to obtain these from the United Kingdom and elsewhere. The construction program was framed with these considerations in view, and orders were placed accordingly with the various civilian shipbuilding yards in the country.

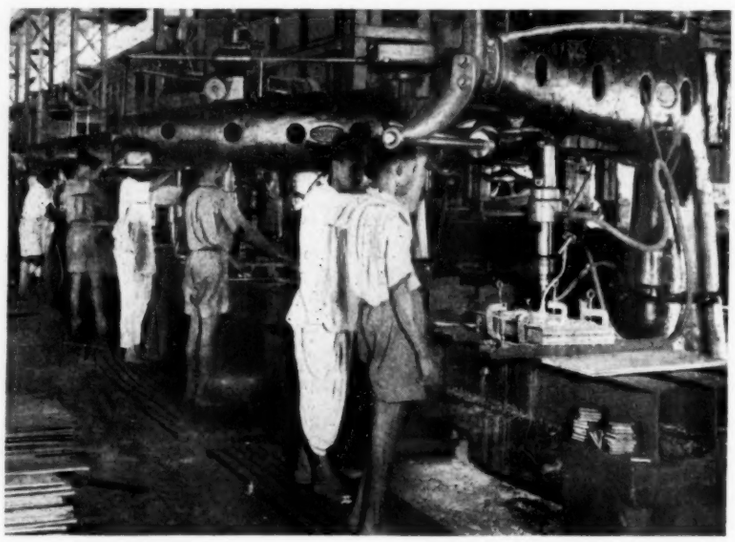
TODAY, these shipyards are engaged in building a large number of naval vessels, ranging from Basset trawlers, Bangors, and minesweepers, to motor launches and lifeboats. The first of the Basset trawlers to be built in India was launched in August 1941. All the shipyards in various parts of the country are fully occupied with war orders, and more orders are waiting to be taken up as slips fall empty.

No propelling machinery or boilers have hitherto been made in India, but an attempt is now being made to manufacture the former, and there is every reason to hope that it will succeed.

India has recently agreed to construct several floating docks for the Admiralty, and work on their construction has begun. A scheme put forward by an Indian firm for the

building of large merchant vessels in India has recently secured the support of the Admiralty. A shipbuilding yard has been opened and work on the plan is proceeding.

BEFORE the war, all armored fighting vehicles were imported in a complete state from the United Kingdom. The building of armored bodies in India on suitable chassis imported from abroad was under consideration for some time, but could not be brought into effect till the latter part of 1940, when Tatas Iron and Steel Works, after a good deal of research, succeeded in developing a bullet-proof armor plate of the required specification. The first Indian-built armored vehicle was produced early last year, and, since then, an increasing number of armored cars, armored carriers, armored lorries, and field-artillery tractors of improved types have been built and sent for service overseas.



INDIAN WORKMEN DRILL ARMOR PLATE

The building of armored bodies for these vehicles is carried out in several ordnance factories and railway workshops, one of the latter being completely taken over for the purpose. Hundreds of tons of armor plate are being produced and delivered to these factories every month, and trainloads of chassis arrive from the motor assembly plants almost every other day. By the end of 1941, several thousand armored vehicles of various types were completed and delivered to the fighting services, and production is still increasing.

As has been stated before, the engineering industry in India is not designed for production in the accepted sense, but it has a fairly large capacity for job work in the structural, mechanical, electrical, and civil spheres. This has been availed of to the fullest possible extent and, together with the manufacturing capacity of the railway workshops, has resulted in the production of a large volume of engineering stores required by the defense services.

In structurals alone, over 200,000 tons of steel fabrications have so far been completed and dispatched for use overseas. These include, to name only a few, sheds, Nissen huts, multiple-span workshops, water- and fuel-storage tanks up to 60,000 gallons' capacity, ethyl-blending tanks, galvanized truck tanks, stagings and platforms, Hamilton bridges, Inglis bridges, swing bridges, stock span bridges, cranes, hangars, trestles, and trench shelters.

In the mechanical and A.R.P. section, large numbers of stirrup pumps, sirens, steel helmets, fire extinguishers, hydraulic jacks, shovels, picks, spanners, pliers, nuts and bolts, washers, screws, wire nails and netting, and numerous other tools and components are being manufactured.

The production of bright nuts and bolts, which had not hitherto been made in India, except possibly in trivial quantities, has recently been undertaken by a railway workshop. Another railway workshop has started the manufacture of roller bearings, an item which hitherto had not been produced in India outside the ordnance factories.

AMONG electrical engineering items, the manufacture of cable and telegraph and telephone stores has been noteworthy. A leading cable company has so far supplied over 50,000 miles of tinned copper wire and telephone wire, while large quantities of a special "degaussing" wire have been manufactured for the protection of ships against magnetic mines. Many other types of cable, wire, and strand for the army, navy, and air force are also being produced.

The workshop of the Department of Posts and Telegraphs has turned out large quantities of telegraph and telephone apparatus and equipment, and is at present developing the manufacture of field-service telephones. A short-wave wireless transmitter and auxiliary apparatus also have been designed and constructed in the workshop. Other notable electrical manufactures are accumulators, dry cells and batteries, transformers, insulators, switch gear, and fans.

It is estimated that India's contribution in railway material for overseas will amount to over $24,042,072 by the time the orders now on hand are completed. The supplies, a large proportion of which already have been dispatched, consist of locomotives, coaching stock and wagons, besides large quantities of track, turnouts, crossings, turntables and miscellaneous railway stores. The supply of railway track alone, in the course of a year, will have run to many hundreds of miles.

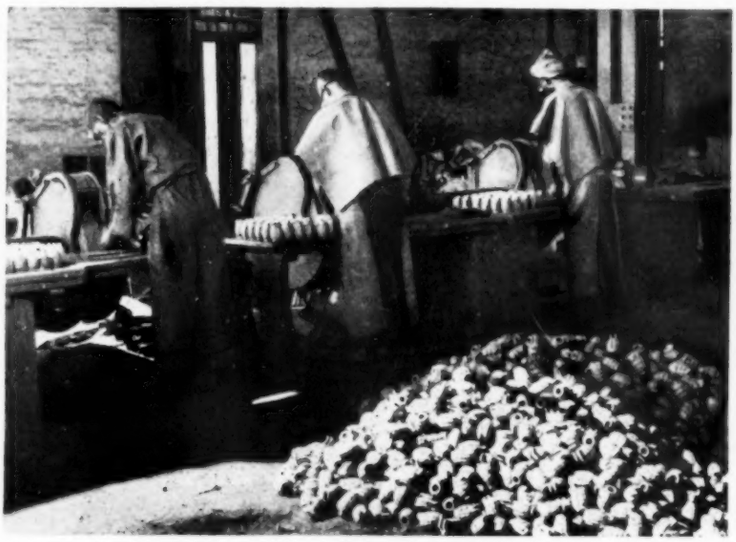
Practically all this material is being manufactured in the railway workshops, whose capacity is being continually developed to meet the growing demands of the various theaters of war. Recently, during a single week, orders for railway stores valued at over $4,507,888 were placed with these workshops for supply to the Near and Middle East. The items comprised rails, fishplates, fishbolts, dog-spikes, bearing plates, turnouts, trough sleepers, etc.

SOME progress also has been made in the manufacture of scientific and mathematical instruments required by the defense services. The Mathematical Instruments Office, which was transferred to the control of the Director of Ordnance Factories in May 1941, has been specially active, while efforts also have been made to organize trade production to the maximum possible extent. The manufacture of binoculars and several mathematical instruments has been established at the Mathematical Instruments Office, while the trade has been largely responsible for the production and supply of such articles as compasses, thermometers and mag-

nifying glasses for the air force, and prismatic glass and opal shades for use aboard ships.

Prior to the war, there was practically no production of machine tools in India, though a few firms made a small number of special machines for their own requirements. Since the outbreak of war, however, there has been a rapid expansion, and, up to August 1941, no fewer than seventy-one licenses had been issued to various firms throughout India for the manufacture of machines covering a wide range. Out of these license holders, fifty are in production.

The most popular types of machines manufactured are lathes (including small capstans), drilling, shaping, planing, slotting and hack-sawing machines, presses, furnaces, power blowers, and sand-blasting plants. It is estimated that the approximate production of machine tools and ancillary plant in India amounts to over 400 units a month, and this figure is rapidly increasing. Besides these machines, various gages, tools, jigs, etc., are also being manufactured in India. The railway toolrooms alone are producing some 1,000 gages weekly for use in ordnance factories, while Tatas Iron and Steel Works is manufacturing 50,000 tools of varied types every month.



HAND GRENADE MANUFACTURE IN INDIA

With the experience firms are thus gaining it should be possible for them in the near future to attempt manufacture of higher-grade machines, and there is every indication that many of these firms will remain in the machine-tool business after the war.

In all these varied developments, the main determining factor has, of course, been the expansion, both in volume and variety, in the production of steel. India's steel industry has been all-out from the first, and it is anticipated that its total output will have been increased by more than a third in the near future.

THANKS to the industry's unremitting efforts in the matter of research, a large variety of new types of special steels are now being manufactured in addition to the usual output of structurals, rails, galvanized sheets, and carbon steels. Among these new types are: a special bar for the manufacture of shells; a bullet-proof armor plate for the fabrication of armored-vehicle bodies; a bullet-proof plate for howitzer shields and gun turrets; various kinds of alloy steels for the manufacture, respectively, of steel helmets, armor-piercing bullets and shot, and shear blades for shearing armor plates; a chrome-molybdenum-alloy steel required in the manufacture of aircraft; spring steels for the manufacture of machine guns; special deep-drawing steels for rifles and machine-gun magazines; nickel-steel plates for gun-carriage mountings; high-carbon steels for the manufacture of high-explosive shells and dies; a high-speed steel for machine tools; and a stainless steel for surgical instruments.

Other manufactures by the industry include steel-mill rolls, steel billets for drawing into telegraph wires and barbed wire, and a steel made to Admiralty specification for shipbuilding. A process for the manufacture of acid open-hearth steel, required for gun forgings, gun-carriage axles, and railway wheels, tires, etc., also has been developed. An ordnance factory is manufacturing shield plates for gun carriages. At another ordnance factory, a record production of tungsten high-speed tool steel recently has been achieved.

IN THE production of other metals also, considerable progress has been made. The rolling mill of an aluminum-production company commenced operations in December 1940, while a smelting plant for treating alumina is nearing completion.

Extruded lead pipes and rolled lead sheets are now being manufactured in India. It is expected that the total demands of India's explosives factories and chemical plants for these essential stores will soon be met locally. The production of brass ingots is proceeding satisfactorily, and a new mill recently has been started for the rolling of these ingots.

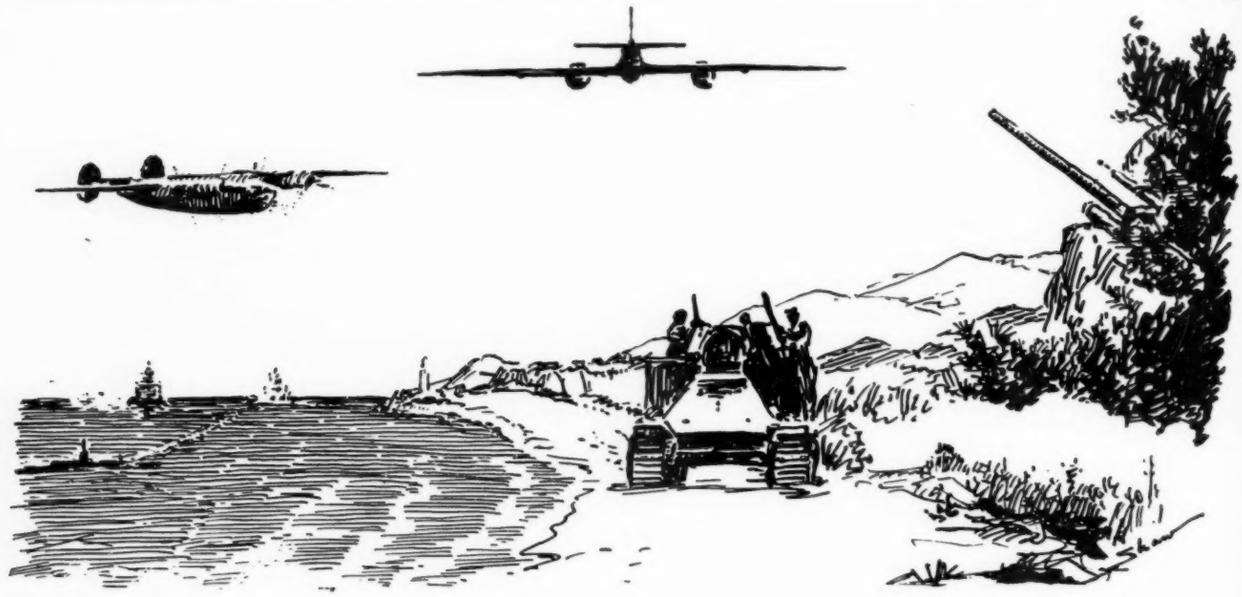
The refining of antimony ore has been undertaken by several firms, and it is hoped that India's total requirements of this metal will soon be supplied by indigenous production. Efforts are also being made to develop the production of zinc, magnesite, and manganese.

A highly useful mineral for war purposes is chromite, of which India possesses a good supply. The development of stainless steel containing thirty per cent chromium has given a great impetus to the use of this metal, and the war has further increased its utility, so that the consumption of chromium is now many times greater than before. Since the war began, attention has been directed to the possibilities of developing a chrome industry in India on a large scale.

Among minerals, the production of coal, mica, and sulphur has been noteworthy. The output of coal has been stepped up to a maximum to meet the growing demands of the war industries, as also for supply overseas. Nearly 1,000,000 tons of coal have so far been supplied by India to the Near and Middle East countries and to the Allied governments since the outbreak of war.

India is the world's largest source of supply for mica, which is an essential commodity in the production of various munitions and electrical stores. The export of mica, which has considerably increased since the outbreak of war, is under strict Government control. Large supplies are now being sent to the United States and the United Kingdom.

Thus India, with increasing efficiency, is meeting the demand of arms production for modern mechanized warfare.



The Revolution in Artillery

The Airplane, Submarine, and Tank Have Outmoded Static Warfare

Col. Henry W. Miller*

IN ROMAN times, a device which would project a stone over or against the wall of a city was known as a piece of siege artillery. The energy to accomplish this was stored up in bent staves, like halves of very heavy bows, in twisted ropes of hair, or in weights elevated by pulling the projecting lever back to the loading position by means of a winch or the efforts of a score of men. Such was the only form of artillery until 1200 A.D.; it was sufficient, however, to breach the walls of Carthage, Rome, Syracuse, Athens, Alexandria, and scores of lesser fortified cities.

Just how it was discovered that the explosive force of the combination of sulphur, charcoal, and raw saltpeter could be used to project a missile from a potlike mortar or tube is not recorded. Saltpeter was probably discovered in India, and the combination of sulphur, charcoal, and saltpeter is said to have been used at Chinese courts in Roman-candle fashion for entertainment. That the mixture was used to mine and destroy walls is certain; some charges may have blown out the hole rather than fractured the wall—for this happens frequently in blasting with powder. This may have suggested the crude beginning of a new form of artillery in which the energy is released in chemical fashion.

A small Arabian firing vessel, made of wood and called a "madfa," may have been the first cannon. Once recognized as a practical method of projecting missiles, the new devices were developed in two centuries to the point where, in 1453, the Turkish forces of Mahomet II besieging Byzantium set up huge cast-bronze cannon, called "bombards," within a hundred yards and proceeded to batter down the triple walls which had successfully withstood sieges of mechanical forms of artillery for ten centuries.

The cannon used against Byzantium weighed about 19 tons and were conveyed on heavy timber skids with some 60 oxen and 200 men required to transport one bombard. In service, a cannon and its heavy timber carriage or base were set on an inclined mound of earth and backed against recoil by heavy timbers set vertically in the earth. The projectile was a crudely fashioned sphere of stone weighing about 600 pounds which was rolled up the mound in front and down the bore of the cannon. The powder was mixed on the field by the master gunner from casks of ingredients.

The value of this crude cannon lay in the fact that enough energy was stored up in the missile so that its impact with the walls battered them down more rapidly than the defenders could repair the breach. When the triple walls of Byzantium were breached, the defenders were too few for the besieging forces, and the city was taken.

IN THE past six centuries, chemical artillery has been developed in a multitude of forms designed to carry tremendous destructive power to such great distances that the destination of the missiles is many miles beyond the vision of the gunners. Weight increased from a few hundred pounds to 100-ton cast cannon, and 150-ton steel ones; in length they have increased from 1-foot mortars to 120-foot guns.

In 1500, it was accidentally discovered that the provision of spiral grooves in a handgun would project a spherical bullet more accurately than a tube that was smooth. Such tubes were said to be "rifled," and the gun itself became known as a "rifle." The early development of a light, long-barreled rifle by Lancaster gunsmiths for use of hunters and backwoods colonists who needed light, accurate weapons to protect themselves probably explains how and why the colonial American levies defeated British forces.

The American colonial soldiers provided their own weapons, mostly lightweight rifles, while British soldiers had only smoothbore "Brown Bess" muskets. When a buck-

*Author: "Railway Artillery" (2 Vols., 1921); "American Seacoast Artillery" (1923); "Mobile Artillery" (1926); "The Paris Gun" (1930). Chairman, Department of Mechanism and Engineering Drawing, University of Michigan, Ann Arbor, Mich. Colonel, Ordnance Reserve, U. S. Army.

shirted Colonial stepped from the shelter of a tree, aimed his rifle and fired at ranges of a hundred yards, he invariably hit his man. That is, he aimed at a man and hit that man at distances at which it was useless to fire a musket. That performance was hard on British morale. In the battle of Waterloo, where British soldiers were still armed with "Brown Bess" muskets, it was estimated that 450 rounds were fired for each man hit.

Curiously, such performances did not result in the introduction of the rifle into any army until 1865 nor the adoption of the principle of rifling in cannon until about 1870, although practically all hunting and sporting small arms made throughout the nineteenth century were rifled. The discovery of a method of making steel cheaply and in quantity by Henry Bessemer in 1857 made rifled cannon possible. The pressures, forces, and stresses in rifled cast cannon had usually burst them with the effect of prejudicing the idea of rifling for cannon.

The discovery of guncotton in 1870 and the colloiding of it into smokeless powder in 1885, together with the availability of steel and improved machining methods, served as the foundation for the development of huge built-up cannon for use in seacoast fortification and on board steel ships. These scientific advancements served as the basis for the development of rapid-firing field cannon, intermediate calibers of field cannon for the destruction of roads, railways, and supply depots, and great siege weapons such as the famous German 42-centimeter (17-inch) mortars firing 1,700-pound projectiles and the still larger French 520-mm. (21-inch) mortars on railway carriages firing 3,000-pound shells.

The limit, perhaps for all time, in this variety of artillery was the German long-range gun—the Paris Gun—which projected a 228-pound shell on a trajectory of 90 miles to attain a range of 75 miles against the target of the city of Paris. This cannon was a tube 120 feet long; the powder charge was twice the weight of the projectile. The total installation on the German front only five miles behind the line was 500 tons, including cannon, carriage, base, and crane.

Other artillery in common use in the World War could be transported only on railway carriages—14-inch guns taken from battleships, 15-inch guns from seacoast fortifications—and some of these railway carriages had to be provided with as many as eighteen axles to reduce the wheel loads to an amount the railway rails and bed could hold. The limit of chemical artillery of this variety had been reached.

IN THE thirty centuries of mechanical and chemical artillery, a piece of artillery had always been a device for projecting a destructive missile against a distant objective with a predictable degree of accuracy. On the discovery of the chemical principle, it became possible not only to project the missile by the stored energy in the mixture called gunpowder, but eventually to make the missile hollow and place some of the powder in it, first to break the missile into fragments on the way and later to delay the bursting of the hollow missile or shell until embedded in the fortification, under it, or inside buildings.

The discovery of high explosives and steel and the adoption of the principle of rifling provided the opportunity to make an elongated, pointed, hard-nosed shell with an intricate fuze so that such a shell could be driven through heavy armor and carry destructive power inside the most formidable land or naval fortifications. Such missiles rendered all fortifications obsolete in the World War and made a naval engagement a slugging contest in which lucky blows, thin skin, rate of slugging, and accurate hitting became telling factors.

IN all the thirty centuries of such mechanical and chemical artillery, land targets were two-dimensional and stationary. The artillery problem of operation against them was relatively simple. When the cannon was registered on the target, a sufficient number of shots could drop shells in a pattern on it to destroy it if the power of the shells was sufficient. Calibers of guns, weights of shells, and high-explosive content were gauged to the targets, and the problem seemed merely one of placing the proper artillery in position and of operating it for a sufficient length of time.

Transportation problems, such as the hauling of a heavy battery of two German 42-centimeter mortars on nine vehicles with large tractors and over hard-surfaced highways or of a 14-inch naval cannon mounted on a specially designed railway gun carriage, were accepted as a matter of course. The tempo and the technique of warfare were such as to permit this.

The second revolution of artillery began in the World War. Accepting the definition already set up for a piece of artillery, we find that in the 4-year period of the 1914-1918 war we extended artillery to the air and under the surface of the sea. Quite obviously, in view of our present world predicament, few if any nations appreciated the terrible import of the World War extension if employed by any formidable group of people led by capable and ruthless leaders bent on partial or total world conquest. World conquest seemed too fantastic to be entertained, and the qualities of the new weapons, the new expanded scope of artillery, were not appreciated by many.

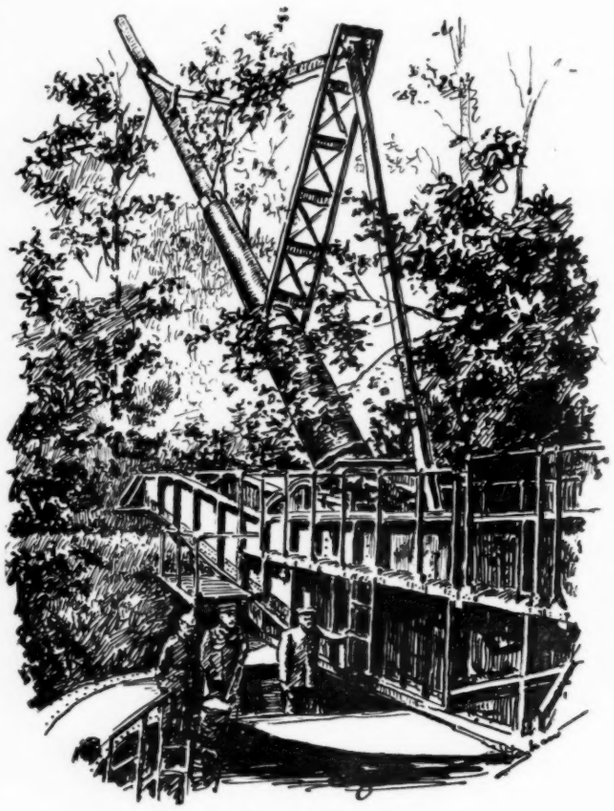
Very early in the World War, the destructive power of a missile projected from a submersible ship gave promise of giving those the mastery of the oceans who had sufficient number of these projecting devices and used them skillfully and ruthlessly. Neither the ability nor the inability to accomplish this had been demonstrated when the war ended. But without question, a new and terrible form of artillery had been introduced. Its targets were always ships. The designs of the devices were obviously far from their ultimate effectiveness; but, even so, their accomplishments were such that with those alone it appeared at one time that Britain and France would be defeated. No perfect answer was found for these new pieces of artillery, and they were certain to appear (vastly improved over the previous designs) if and when another war began. They have appeared, and again we are not certain of the answer nor even if there is one except the complete destruction of their sources and their bases —and that is a more than difficult solution.

A second invention, which appeared in warfare for the first time in 1914 as merely a reconnaissance device, has become artillery. It was a powered machine to traverse the air —taking off at prepared places, landing at prepared places, soaring at any desired height, maneuvering rapidly and at will and traveling to ever greater distances. Given time for development, this device was certain to become one for projecting a destructive missile upon an objective with a predictable degree of accuracy. Before the end of the war it had become such, though still crude.

For the first time in history it had become possible to drop

half a ton of high explosive on a fairly large target from take-off distances across which nothing had ever been projected. A device which had appeared as merely a novel but tremendously valuable reconnaissance instrument became a transporting and projecting device with prospects as a new form of artillery for which there literally appeared no answer. Ruthlessness could now have its way—given sufficient preparation and corresponding indifference or lack of preparation on the part of prosperous nations who would be the intended victims.

Intervening years have seen this device developed to one of great carrying capacity, tremendous speed, and uncanny accuracy as a piece of artillery. Sighting devices, streamlined projectiles, and split-second releasing mechanisms have kept pace with the development of the carrying and projecting device, to the end that there is still doubt as to whether the most heavily armored battleship can withstand bombardment from a strong concentration of such artillery manned by competent and daring operators. The British aircraft carrier ILLUSTRIOUS suffered seven direct hits on its flight deck in the air bombardment which it suffered in an all-day battle in the Mediterranean. One of the bomb projectiles passed through and blew out a hole in the side of the ship. She survived by a miracle.



THE PARIS GUN, FOREST OF CORBIE

And the answer? It is not in sight. Such an instrument naturally becomes a target which must be destroyed. Here for the first time we have a 3-dimensional target—a space problem. And the targets about which we are most concerned, heavy projectors, travel at the rate of 300 miles an hour, or 440 feet a second, and can change position in any direction.

This same air artillery is being employed to project submarine torpedoes against ships with highly destructive effects. Descending at steep angles and tremendous velocities, they are projecting their destructive missiles with fine accuracy upon the decks of ships, on land fortifications, railways, city utilities, factories—in short, upon anything that forms a profitable target in total warfare.

It may be that the only even partial answer to this new air artillery is other air artillery, fast and armed with automatic cannon. This, at least, is one upon which all nations are concentrating. Before the end of development is reached, we may be arming the self-propelled antidevices with 75-mm. cannon; 37- and 40-mm. cannon are already in routine use firing high-explosive projectiles with fuzes so sensitive that they burst the shell on impact even with large-sized raindrops.

The other partial answer to air artillery is in an uncanny development of land artillery. With instruments so intricate that their use in warfare seems impossible, we predict two miles in advance of the instantaneous position of a piece of air artillery just where it will be in thirty seconds when the projectile from the land cannon bursts at that rendezvous. The talent, money, and painstaking labor spent in perfecting these devices indicates our full present appreciation of the deadly peril to the existence of nations from the ruthless use of great concentrations of the new artillery. Given time and full appreciation of the peril by all, a rich nation may answer that peril with great quantities of the new air artillery and equally great quantities of modern special land artillery for use against air targets. Given time!

A THIRD device appeared in 1915 as a powered and armored battering ram to destroy machine-gun shelters and breach trench lines. It had the inappropriate name, "tank." As then designed and built, it was slow, clumsy, unwieldy, vulnerable, and more than faulty in construction. It was not taken very seriously. The writer saw a group of 19 of them destroyed within a 20-acre area, each by one shot from a concealed German 77-mm. field gun. They were the victims of a crawling speed, thin skin, and their own poor gun power.

But astute observers saw their possibilities. Given reliability, speed, armor, gun power, large numbers, and the assistance of air artillery to clear out centers of resistance by perfectly coördinated action, they would be terrifyingly formidable. Those who would conduct research to develop powerful types, construct sufficient quantities, and build the necessary manufacturing facilities for the replacement of casualties would have their neighbors at their mercy. Ruthlessness in the use of this new, highly mobile, armored form of land artillery would be all important.

There would be need for costly development of specialized types of this as well as of the air form of artillery and for a staggering outlay for the building of the manufacturing facilities alone and a greater outlay for the artillery itself. But given a grandiose plan, sufficient capacity for management, corresponding qualities of ruthlessness and deception, and a horde of fanatical followers, what could not be done! And suppose a group of ruthless leaders were to employ all three of the new forms of artillery, having had a dozen years to conduct research, plan and build facilities, manufacture the artillery in vast quantities, train the fanatical followers into skillful specialists in the high-speed or *blitz* use of all of it, perfectly coördinated, and with utter disregard for all the accepted usages of humane beings, what then?

We have seen and continue to see "what." The second revolution in artillery in the hands of capable, ruthless men has well-nigh overturned the world. We hope it will not, but the end is not yet in sight.

Since the effect of the second revolution in artillery is to keep things boiling, to render stationary warfare impossible, and to put a high premium on extreme mobility, one might predict that the effect on the equipment of previous wars will certainly be profound.

The World War saw the development of great quantities of the heaviest types of artillery. Difficulties in transportation were not regarded as reasons why it should not be built, and methods were suited to the weights involved; that is, the huge wheeled artillery was broken down into loads that vehicles could carry on surfaced roads. Still more powerful cannon were mounted on railway carriages and were employed for long-range destruction service. Now, air artillery has supplanted both of these, and it is not probable any army will build much, if any, siege artillery in the foreseeable future.

Every conceivable variety of intermediate-caliber artillery was employed in the World War for shorter-range destruction service. The intermediate and heavy artillery have relatively little direct effect upon personnel. They are employed to prevent movement of supplies, evacuation of wounded, to destroy supplies, to harass the headquarters of army administration. The great 14-inch American guns on railway carriages kept the vital Sedan-Metz railway continuously out of commission in the final month of the last war. Six-inch long-range guns on wheeled carriages were used to make roads approaching a front unusable. But in both cases it is clear that the use of each involved the existence of a relatively stabilized condition of warfare and an ability to conceal or protect the artillery itself from destruction. A prime function of such artillery on both sides was to destroy that of the other army.

With the rapid, efficient, and enormous development of air artillery, the static condition of warfare on which both intermediate and heavy artillery depended has disappeared; furthermore, the function of each can be better performed by the new artillery which makes their use nearly impossible. And since the new artillery always has the added and unusual quality of direct fire, that is, self-observance of action on the target, concealment is well-nigh impossible where motions of men or supply vehicles may be observed.

One more point is important. Having ruled out the heaviest artillery—heavy siege and heavy intermediate guns—what remains? The blanket answer is: Whatever the field forces clearly need and can profitably incorporate into their transportation systems. An army will haul along almost anything that will destroy the two new forms of army artillery—the mobile armored form called tanks and the air form—because it must defend itself against these or be destroyed by them.

But what more? Probably any heavier form of artillery, up to six inches but not much beyond, that is so highly mobile its transportation will not interfere with rapid movement of such large army units as divisions and corps. They may not be sure of just what their targets will be and may feel that in any event they can best destroy those targets by air artillery provided they have it and can use it. But they will cling to the belief, and logically so, that they may tear up roads over which enemy tank artillery will have to advance, may conceal themselves, and may operate more continuously and longer with this form than with the air form. They may change their views by the end of this war. Even the 6-inch longer-range guns may have disappeared in the next two years. Mobility will be the urge to the point of obsession, and rightly so; for he who can move himself and all his equipment most rapidly, dependably, and for the greatest distances has the best chance of avoiding destruction and of being the victor. It bodes ill for the comfort of men and the problems of supply, but such is certainly the product of the revolution in artillery.

AND what might have been done to prevent all this? We have said that those who have gone so far in the destruction and looting of nations and the enslaving of peoples conducted years of research and development in perfecting the devices they have built in such great numbers. There is no magical road to the possession of any instrument of destruction or defense. Those leaders compelled their people to build vast facilities for the quantity production of the developed artillery devices and all additional war equipment on a scale we thought fantastic. And it is now costing us a complete dislocation of our accustomed way of living and so many billions of our wealth that we cannot comprehend it.

In view of all that we must now accept as a reality, what should we have done? The nation is terribly concerned and is taking the Army and Navy to task for not being prepared and for not having every device necessary to meet the second revolution in artillery developed and ready for production.

At the time of Munich, how many Americans were ready to face all that we have done since? And had they been as ready then as now, how much more progress could have been made, not only in preparing to meet the threat but in actually meeting and disposing of it? In every one of our great national emergencies some "lucky break" or fortunate change has come to our aid. In the Revolution, our men used rifles, the British soldiers worthless muskets, and Britain did not support her colonial army. In the War of 1812, England was preoccupied with a war with France. In 1863, General Lee chose to fight it out with Mead at Gettysburg against the urging of some of his ablest generals, and the Confederacy missed out on European recognition. In 1917, England and France still had a year's stiff fighting resistance and an ample supply of artillery for our use. Now, Hitler has blundered in attacking Russia, and Russian resistance and morale have surprised every one.

But in the history of every past empire there came a time when blind chance failed the easy-going, careless people who were the descendants of one-time lean, hungry, hard-working, hard-fighting migrants or perhaps conquerors of a previous empire. What a bill we are paying for our easy-going blindness!

Research and development never dare stop; a generous allotment should always be made for it. Most of the equipment in our arsenals should be scrapped every ten years; housing for production must stand perpetually ready; obsolete war equipment should be scrapped and replaced as soon as a better variety appears. Perhaps the engineering divisions of our military departments can profitably be associated with industry in times of peace for design, development, and peace-time replacement of war equipment. And a free, easy-going people should remember, if there will be any remembering, that anything can happen, because they have seen it happen!

Two Decades of Ordnance Service

The Twentieth Anniversary of the Procurement District System

ON Monday, May 18, 1922, the present system of Ordnance procurement districts was established. In celebration of the twentieth anniversary of the event, the personnel of the district offices and friends in industry gathered at luncheons last May 18th to hear radio addresses by Lieut. Gen. Brehon B. Somervell, Commanding General, Services of Supply, and Maj. Gen. Charles M. Wesson, then Chief of Ordnance.

The present Ordnance procurement set-up is an outgrowth of the system used in World War I and established early in 1918 under the direction of the late Brig. Gen. Guy E. Tripp to decentralize procurement. It was a result of intensive study of the best methods for obtaining complete munitions production throughout the country in an emergency.

On May 18, 1922, Maj. Gen. C. C. Williams, then Chief of Ordnance, created thirteen Ordnance district offices. A fourteenth office was created August 13, 1923, at Birmingham, Ala. Subsequently, one of the district offices became an Ordnance region, and today the office at Los Angeles, Calif., is a regional office.

At the beginning of the First World War, Ordnance procurement was centralized in Washington. Manufacturers had to come to Washington from all parts of the country to find out what they could do for the Ordnance Department. The district system established by General Tripp had more satisfactory results. For a short time after the Armistice, the district system was discontinued, but it was studied closely by Army officers intrusted with developing the Ordnance procurement factor in the Army's future mobilization plans.

In the early days, the Ordnance district offices were mostly small affairs. They were then, and still are, directed by a civilian district chief whose aide, the deputy district chief, is an officer of the Ordnance Department. They conducted surveys of industries within the district to determine just what each manufacturer could do to produce war matériel in a national emergency. Many manufacturers closely cooperated with the Army in making these surveys, and a number of them spent considerable sums of their own money for this purpose.

When the present emergency became intensified in 1938, General Wesson visited many of the district offices and directed their expansion. When the all-out war production program got under way, the Ordnance Department had ready for operation a system which, with the expansion required by the volume of business, was able to carry the load. During the month of March, a total of 10,495 prime contracts and 56,743 subcontracts were being inspected in the Ordnance district offices. A total of 30,258 people made up the personnel of the district offices during that period.

General Somervell spoke as follows from Washington, D. C., during exercises commemorating the twentieth anniversary of the district system:

"SEVEN thousand industrial concerns and many times that number of individual plants are turning out ordnance for the American Army. I'm not talking about blueprints. I'm not talking about products on order. I'm not talking about the future. I am talking about ordnance rolling off the assembly lines—I'm talking about right now!

"After less than six months of war, these 7,000 companies are 7,000 rousing answers to Hitler's boast that a free people can't produce. Hitler's running into our guns and tanks and munitions on scores of battle fronts from the Arctic to Africa. He doesn't like them. He doesn't like the quality of our effort, and he doesn't like its quantity. He can blame his reverses on the Russian winter. He can blame them on the Libyan sun. He can run through the whole decalogue of geographical alibis—but geography isn't Hitler's strong point. He hasn't found out yet what he's going to find out about Michigan and California, New Jersey and New York, Pennsylvania and Illinois. He'll know a lot more about geography when the forty-eight American states reach their production peak.

"Your job in ordnance—whether you belong to the Army or to industry—is to reach that peak in the shortest time possible. We know what you have accomplished already, and, with that as a yardstick, we know what you can, and will, accomplish.

"All Americans and all free people owe our ordnance industry a debt of gratitude for the superb job it has done in these six months. The leadership furnished by General Wesson and his assistants has been outstanding. The engineering genius, the immense capacity for work, the astounding ability to overcome obstacles, the eager willingness to do its part—these are qualities of American industry that will turn the advantage in our favor before we're done. These qualities of what Hitler calls our 'decadent democracy' are nowhere more apparent than in our ordnance program.

"This is no time to boast, however. We've not won the war—we've merely set ourselves the task of winning it. We have suffered losses already; we will suffer still greater losses before we win. But we have this encouragement—no matter what outposts we have lost—that these reverses and these losses are only temporary. We've been winning every day on the production front, and these successes in the end will tell the story on the battle front.

"How far we have advanced in production of armaments is a military secret. You gentlemen know what you have done in your own particular fields. If we were to add up each of your individual successes, we would have a proud record to show the world. Thanks to your efforts, your intelligence, your whole-hearted coöperation, our hopes and Hitler's fears are being realized.

"From time to time and with increasing frequency we will hear good news from our far-flung armies. Let us not allow that good news to influence us any more than the bad news does. It is just as important at this stage not to be overconfident as it is not to be discouraged. No matter what the headlines say, let us be determined and resolute; let us be obstinate in the rightness of our cause, tenacious in holding the gains we've made, stubborn in our refusal to compromise. Let us set new goals of production—goals undreamed of six months or six weeks ago. And let us attain those goals. It's not going to be easy; it will require still better organiza-

tion, still greater individual sacrifice, immense labor, all the genius, all the skill, all the determination, all the perseverance of which we are capable.

"We don't intend to fight this war to a stalemate; we intend to win it. We intend to end it our own way, on our own terms. To you men in Ordnance who have done so much, a trusting nation says: 'Do as much more.' To you in industry the Army says: 'Give us the tanks and we'll keep 'em rolling! Give us the guns and we'll keep 'em hot! Give us the shells and we'll send them—with your message on every one of them—to the places that will do us most good and the Nazi and the Jap most harm.'

"We're in this thing together—the Army and labor and industry, the people of America. Together we'll fight it out. Together we'll win!"

GENERAL WESSON also made the following address on the same program:

"It is not by mere chance that the production of our guns and ammunition and tanks has reached such great volume in the United States after only six months of war. Our Ordnance effort has been planned for years, and one of the most important elements of that plan is what we of the Army call the Ordnance district system, the twentieth anniversary of which we are observing today. Let me describe this system briefly.

"When we of the Army or the men of American industry refer to the Ordnance district system, we mean a great cooperative organization composed jointly of the Army and private industry spread throughout the country for the production of military armament. The principal characteristic of the organization is that control is administered by the Army in Washington, but actual operation is decentralized to private industry through the local districts. There are thirteen such Ordnance districts in operation today, each having its headquarters in one of the larger industrial centers.

"These districts embrace the entire industrial and engineering strength of our country from Boston to Los Angeles. They and the system of which they are a part are not a creation of the past year or of the past decade. They grew out of our munitions-production experience in the World War. The lessons learned by the Ordnance Department of the Army in our war effort twenty-four years ago to produce arms for the fighting men of America have never been forgotten. Those lessons learned by the Army and by industry are now paying dividends a thousandfold.

"We of Ordnance were among the few people in the United States who, shortly after the First World War, were not of the opinion that wars were a thing of the past. One of the far-reaching phases of the postwar period of preparation for future wars was the development of the Ordnance district system of decentralized procurement. During the latter part of the World War, the Ordnance program was slowing down because of the centralization of procurement then in effect. A decentralized system was set up under which ordnance procurement was apportioned to thirteen districts. Covering the entire country, the areas of the districts varied with the amount of industry located within their boundaries.

"The Ordnance districts were reactivated twenty years ago today and have been in operation continuously since that time. An experienced Ordnance officer of the Regular Army was detailed to each district headquarters, and a prominent civilian, well known in the industrial life of the region, was selected as district chief. The district chiefs and their civilian advisory boards served patriotically without compensation. Their Regular Army executive officers set up tiny organizations consisting of one or two clerks and advisory engineering and industrial groups. These officers undertook a detailed survey of the principal industrial plants lying within their district confines and selected those plants best qualified for the production of specific types of ordnance matériel. Thus, the entire ordnance war-time load as then estimated was allocated to individual private producers.

"DURING the First World War, one of the serious difficulties encountered was the fact that orders for the production of armament were placed with many companies which were not properly equipped to produce the weapons or parts of weapons assigned to them. But under the present Ordnance district planning system it was possible, during the days of peace, to search out companies best qualified to produce certain definite classes of ordnance equipment. In this way, approximately 15,000 plants throughout the United States were surveyed by the Ordnance Districts and selections made of those best adapted to manufacture the various types of ordnance with least transformation of plan. The companies thus selected worked out production plans in conjunction with our district officers and without compensation. They studied the drawings and specifications and in many cases made factory layouts of machinery.

"In the present emergency, the Ordnance Department turned first to these surveyed and allocated facilities. Some eighty-four per cent of these same allocated manufacturers now have orders for the production of armament under our present mammoth munitions program. I can candidly say that had it not been for the Ordnance district system during the piping days of peace and had that system not received the enthusiastic support of American industry throughout the years, America's effort in this war would not now be nearly as far advanced as it is. The men who worked hard on that system in days when the mere mention of the advisability of even small armament production in this country was held up to ridicule deserve the undying praise and thanks of the entire American people.

"In reviewing the district system we should not be unmindful of that group of men in the First World War, both in the Army and in private industry, who undertook the establishment of this organization. The problem presented many difficulties and demanded great speed. The late Brig. Gen. Guy E. Tripp, formerly chairman of the board of the Westinghouse Electric & Manufacturing Company, was induced by the then Chief of Ordnance to head this group. . . .

"I wish particularly to felicitate the officers and employees of the Ordnance districts, many of whom are now assembled in their various cities under the auspices of local chapters of the Army Ordnance Association to listen to this broadcast. It should be a source of real consolation to them as well as to all the citizens of our country to know that for the past twenty years the Ordnance district system has been planning and getting ready for the present effort. The results we are now achieving are in great measure due to the loyal efforts that were applied in the Ordnance districts throughout the years. I congratulate all the personnel, I thank them most heartily, and I urge them to continue the magnificent work in which they are now so whole-heartedly engaged. The Ordnance district system of armament production is a mighty force in our march to Victory."

Problems of the Ordnance Maker

A Case History of Industrial Preparedness at Work

C. A. Liddle*

LESS than two years ago, weeds grew in the roadways of one Pullman-Standard freight-car plant. Virtually abandoned for newer car-manufacturing facilities at this company's other plants since 1934, the deserted factory buildings seemed one of industrial America's unlikeliest spots for new production of any type. Then, with all its repercussions for the United States, came the fall of France. Today, several thousand skilled employees—the precise number a military secret—swarm through the plant day and night. But their tools are not busy with freight cars—from the production lines of the once-deserted plant comes a stream of varied ordnance matériel.

FROM time to time ARMY ORDNANCE *has published in its pages accounts and descriptions of the conversion of peace-time industrial plants to war production. The purpose of these articles has been to keep American executives and engineers informed of the part their establishments could be expected to play in a major war effort, and to acquaint them with some of the problems, and their solutions, involved in such a task.*

The difficulties encountered by private industry in reaching all-out armament production have indeed been tremendous, but American ingenuity, determination, and loyalty have, in the end, conquered all obstacles. And this victory has been aided in no small part by the splendid coöperation and self-sacrifice of the members of industry and the officers of the Ordnance Department. The accompanying article is another example of industrial conversion to armament production for Victory.—EDITOR.

But whatever armament production has been achieved has been purchased at the cost of both mistakes and heartbreaking trial and error—and there is still much to learn. But if, by revealing mistakes as well as successes, this article can be of assistance to other manufacturers now converting their plants to ordnance, it will serve a useful purpose. Certainly, with America's present desperate need for arms—not a year or six months hence, but *now*—every scrap of information which may prove of value to new companies in this all-important field should be put down in black and white without delay.

From experience, it seems that one of the points on which new ordnance manufacturers should exercise even more than usual care is the reliability of time-load studies. In the case of a Pullman-Standard plant, for example, numerous machines on order did not arrive on time, with the result that when they *did* show up they had to be spotted wherever possible, rather than in their prearranged places in the production line. Naturally, even though this situation was no fault of the engineering staff and has since been largely corrected, it did prove that even the most careful time-load studies aren't necessarily infallible.

Similarly, it was discovered that old converted machines had difficulty living up to their scheduled production. Although months of valuable time were saved by such conversions (in most cases these machines had operated from line shafting, and had to be converted to modern drives), nevertheless certain difficulties were found in stepping up their production as much as had been hoped. One of the difficulties encountered in this connection, for instance, was an underestimation of the time required for boring and grinding operations on armor castings. Such castings are naturally exceptionally hard and entirely dissimilar from any castings we had ever worked with in peace-time production. In fact, for the first few months such work on castings actually required twice as much time as had been originally anticipated. By sending our own men to the steel mills which produced these parts, and working with the mills in producing castings with less excess metal, the time spent in machining them soon was cut by an appreciable margin.

BECAUSE of these experiences, the conclusion seems obvious that nothing in ordnance manufacture is more necessary than a realistic attitude toward the capabilities of the manufacturer's plant. Many parts on items of ordnance resemble, in outward appearance, similar parts on ordinary commercial products, but the ordnance parts are usually vastly different, in so far as difficulty of manufacture is concerned. The new manufacturer should understand, by the very nature of ordnance designing, that it is extremely important for the ordnance item to be as accurate as it is humanly possible to make it. Obviously, for instance, a gun is of little value to troops in the field if it is not extremely accurate in operation. The only way that this extreme accuracy can be obtained in the item as a whole, is by maintaining extreme accuracy in the manufacture of all the parts that go to make up the item. The ordnance designer, as far as possible, must leave nothing to chance, and it is only natural that the drawings and specifications issued by the War Department are therefore very precise. Naturally, this precision must be extended into the manufacture of the parts contemplated, and this the prospective manufacturer should never overlook. Thus, the manufacturer who is now going about the job of selecting ordnance suitable for his plant should be realistic. He certainly will be unwise to underestimate the inherent problems of armament manufacture.

In stressing the need for realistic thinking, however, defeatism should not be promoted. Actually, many a manufacturer fails to recognize the fact that his plant is capable of precise manufacture far beyond anything it ever actually has turned out. Alterations—some difficult, others simple—will be necessary plus additional training of his men, but neither of these problems should prove insoluble. This is no time to be timid or fearful, and, obviously, every available facility must be used. Therefore, we must turn on our ingenuity as well as look at our shops with a candid eye. As

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Signal Corps

THE 105-MM. HOWITZER ON THE RANGE

a matter of fact, one very simple precaution will be of immense help to the man who is about to undertake war work; that is, visiting a plant where the same items he plans to manufacture are being made. Thorough discussions with the works manager and his men, plus a close study of the production lines, will prove invaluable.

The problem of securing competent subcontractors is, as everybody knows, a big one to prime contractors now. Inasmuch as the Pullman-Standard Company undertook very early to sublet everything it possibly could, it has evolved a system which has worked very satisfactorily and which should be of aid to others.

The following are six rules which guide the company's work with machining subcontractors and which we recommend to others:

1. Don't expect the competent subcontractor to come to you seeking work these days; you must find him. Your local Ordnance district office can help you in doing this. Study his equipment to determine what arms parts it can make. Our field engineers saw a milling machine turning out light furniture casters of soft metal but which was readily adaptable to milling steel drop forgings weighing a pound and a half. The owner of the shop had not been aware that he possessed equipment which could be used in war production.

2. Beware of the very low bidder; he probably doesn't appreciate the difficulties of precision manufacture. Satisfy yourself that he can produce before letting a contract to him. On the other hand, investigate every low bidder carefully. We were suspicious of a manufacturer whose bid was exactly half of the price we deemed fair. A visit to his plant disclosed that he had devised a vastly improved manufacturing method which actually cut costs in two.

3. Give your subcontractor every aid possible. We have found it to our advantage to provide subcontractors with our time studies and route sheets as well as with special fixtures, tools, and gages. In fact, we give our subcontractors the same instruction, help, and consideration which we give our own foremen. We consider them a part of our organization.

4. Send an engineer into the subcontractor's plant to set the job up. Having watched the operation performed before, he can take "bugs" out before they have a chance to develop.

5. Send in an inspecting engineer periodically to check the operation.

6. When the product is delivered, inspect it thoroughly and give a copy of the inspection report to the subcontractor. If there are rejects, tell him exactly what was wrong. In addition, inform him of any tendencies detected in his work, such as dimensions which are not being held accurate, which, if they grow worse, might lead to rejections in the future.

PLANT conversion to ordnance making in double-quick time is, of course, the most serious single problem the new armament manufacturer must face. At the time we signed our first contracts with the Government, one of our plants was manned by a skeleton crew consisting of the manager, his secretary, and sixteen foremen and watchmen. This meant that we had to build a staff practically from the ground up and, just as important, obtain the machines without which the new staff would have been useless.

Even in the fall of 1940, when we received our first contracts, speed was a watchword with the U. S. Army. Yet with the machine-tool industry months behind on orders, immediate procurement of new machines proved impossible in many instances. We therefore made every effort to adapt used equipment to our new needs. Our specific accomplishments along this line—of which we are frankly proud—have been paralleled elsewhere since emergency production began, but mentioning a few specific examples might help the manu-

facturer who is now in the process of setting up his plant.

One of our machinists, for instance, was given the task of securing lathes for a specific purpose. He secured three discarded lathe beds, some other used parts (most of which he picked from scrap bins at the plant), and in five months had the lathes in operation, at the same time saving about $25,000. Approximately one year was saved by not waiting for new machines. Moreover, how efficiently this conversion was performed is revealed by the fact that rejects from the three machines have averaged well below one per cent.

Similarly, our welding manager constructed an automatic bogie-wheel welding machine from a scrapped planer. To prevent a long wait for new boring equipment, we converted several old drill presses into horizontal boring mills. And, because of the stringent shortage in gages, we even set up a shop to construct our own. Such ingenuity, I am convinced, is to a large extent responsible for our exceeding almost every one of our production quotas.

Another significant factor in speeding up both plant conversion and production is the expediter. Our crew of expediters, now numbering more than a score of experts, is on the move constantly. They have uncovered usable machinery in home workshops and junk shops, sped subcontracting work by a startling margin, and seen to it that orders from every variety of manufacturer have reached us in time to fit into our production schedules. No ordnance maker, I am convinced, can function efficiently without them. In this connection, the Ordnance districts, with their expert knowledge and advice, have been a great help.

Our personnel office, of course, began functioning long before our plant was completely ready. Inasmuch as our first orders were received when we had only a handful of men, our organization had to be built up from scratch; moreover, there was no convenient reservoir of labor skilled at ordnance making. It was necessary for us not only to select men for jobs, but also to train them in their jobs. In the training work, we made use of every educational facility that our district afforded. The national-defense training program had been set up by the Federal Goverment, and several accredited vocational schools were in our vicinity. Altogether we employed more than 400 men who had received from 6 to 10 weeks of initial training in courses in these schools. We placed them under skilled hands for several weeks, and then they were ready. Incidentally, this group, which consisted of young men for the most part, has proved to be most satisfactory.

Because of this experience, it is our opinion that a manufacturer is overlooking a good opportunity if he does not utilize local vocational training facilities. We went out of our way to assist our schools to obtain training equipment. Moreover, a number of our foremen and skilled hands served as instructors.

ONCE a plant is in full operation, what can management do to increase production? As an example of what can be accomplished in this respect, let me cite one manufacturer's experience with the production of a certain item. Although the scheduled output was attained, after some initial difficulties, the plant management was not satisfied. Therefore, practically every night for a month the general superintendent and other factory executives, from chief electrician to head carpenter, returned to the plant after a grueling day's work to try to speed up the line still further. Working for several hours each night—sometimes as much as five and six hours—they evolved plans for additional conveyers, extra work benches, cutting down time between operations. Numerals had been stamped by hand; a machine was designed to stamp them. A grinder, in one operation, instead of a lathe, doubled cutting speed and entirely eliminated rejects. The result has been that today this plant has the capacity to turn out exactly twice as many units as it had a few months ago!

Two other devices have been found particularly valuable in increasing over-all plant efficiency and production. First is our safety program: Every man who works for us knows that we want him to be safe and are willing to make every effort to remove the hazards from the work he is doing and from the shop in which he does it. Secondly, to expedite work and stimulate morale, a "suggestion system" has been instituted by which men are rewarded for turning in acceptable suggestions for increasing the efficiency and safety of operations, or even for increasing the convenience of operations. Cash prizes are awarded for suggestions in the former category; merchandise for "convenience" suggestions. I can think of no device so effective as this one in enabling the American worker to give practical expression to the fervor he feels toward our whole war effort.

What such employee suggestions have meant in terms of actual increased production—let alone the increased interest of the employee in his work—add up impressively. One worker suggested, for example, that instead of machine grinding certain castings to remove excess metal, an air hammer and chipper be used. On some castings, this procedure saved as much as two hours. Another employee, after laboriously scraping and wiping off the heavy grease in which a product was encased, had an electrically heated barrel rigged up to melt the grease away—a simple trick, yet it saved an hour per unit. Other hours were saved by the invention of new cutting gages, by simplifying grinding, and similar operations. When such hours are totaled, they mean that armament may be ready for shipment days ahead of schedule—and may result in winning a battle for the United Nations. The importance of the employee-suggestion plan has been stressed by Donald Nelson, chairman, War Production Board, who has recommended the installation of suggestion boxes in every factory in America which produces armament.

In conclusion, I wish to stress one final point: Give the fullest coöperation to the officers of your Ordnance district. They have been and are heavily burdened by the intense pressure for production. They deserve your help. In my business experience and in the experience of other executives of our company, we have yet to have dealings with an organization which is more capable, more understanding, and yet more exacting than the Ordnance districts with which we have worked. In fact, if we have been successful in our arms-making endeavor to date, we must give a great deal of the credit for that success to the constant help of the officers of the Ordnance Department.

EDITOR'S NOTE.—The Ordnance manufacturing arsenals have been of tremendous value in aiding private manufacturers to convert their plants from peace-time work to war-time production. After World War I, these arsenals were the principal sources of ordnance research and development in spite of very limited funds. During this trying period they kept alive the art of ordnance manufacture and worked out techniques of mass production which were made available to private industry. Today, the Ordnance-industry team assures America's forces of enough matériel—and "on time."

Squad Armament

The Weapons Necessary for Fire Power and Mobility

Capt. Melvin M. Johnson, Jr.*

THE two elements of force required in the infantry squad are fire power and shock power. There are three main classes of infantry squad weapons designed to provide those elements at various ranges. These classes are: (1) Flat-trajectory weapons—machine guns, rifles, submachine guns, and pistols; (2) High-angle fire weapons—mortars, light mortars, rifle grenades, and hand grenades; (3) Hand-to-hand weapons—heavy or light bayonets fixed to rifles, broadswords, machetes, trench knives, and daggers.

The characteristics of weapons of the flat-trajectory type are presented briefly in the table on page 99.

As we are concerned with the 12-man squad, primary stress must be laid upon mobility. Therefore we must confine ourselves to weapons which may be readily carried by the individual soldier on foot for a reasonable distance.

An examination of weight statistics tends to eliminate the heavy machine gun and the mortar from the squad; these weapons clearly must be assigned to a special-weapons squad.

We are now ready to examine several alternative proposals for arming the squad, as follows: (1) Give the squad all one type of weapon; (2) Give part of the squad one type of flat-trajectory weapon and part one type of high-angle-fire weapon; (3) Scramble all the weapons together, and issue one of each; (4) Study the actual, probable, and possible requirements of the squad on the offense and defense and issue weapons best suited to the requirements disclosed. In following this proposal, issue as few types as possible to simplify the squad armament, but, nevertheless, insure sufficient versatility of fire.

These proposals and the arguments in favor of the various weapons may now be analyzed in detail. Let us first consider those relating to arming the squad with one type of weapon:

A. Historically, the infantry squad carried a rifle with bayonet—two venerable, inseparable, conservative, and time-honored weapons. Supporting fire comes from heavy machine guns and artillery.

B. Train every man to be a sniper; give him a match rifle with telescope and teach him to get a hit every time he pulls the trigger. Teach him to sneak forward and stalk targets.

C. Give every man a semiautomatic rifle. Teach him to shoot as accurately as training time will permit.

D. Give every man a submachine gun. He cannot hit anything over 200 yards anyway, even if he had a rifle. The submachine gunner can carry more rounds, so he can spray more lead. The real job of the squad is to fight at close quarters.

E. Give every man in the squad a light machine rifle which he can operate as a machine gun at longer ranges, as a rifle or machine gun at medium ranges, and as a rifle or a submachine gun at short ranges.

F. Assign a light machine gun to each pair in the squad, one to operate the gun and the other to carry ammunition and act as an assistant.

G. Of what use is flat-trajectory fire when every one is usually under cover, out of sight? By using light mortars or rifle grenades the entire squad can plaster the enemy in their holes as well as out in the open.

Considerable argument in favor of the one-weapon squad proceeds upon the proposition that the infantry cannot move without supporting weapons; that the squad is of value only at close range. Therefore, give the squad a rifle or even a submachine gun. If the enemy is really dug in, only heavy mortar and howitzer fire will move or neutralize him, without which support the squad will be useless.

The submachine-gun argument proceeds along the same ground, except that it generally presupposes a poorly trained, somewhat inefficient squad whose members cannot hit anything with a rifle, but who can spray pistol lead at short range.

The efficacy of accurately aimed, deliberate rifle fire, either from rifles or semiautomatic rifles has been historically exemplified by the Boers, as well as by the U. S. Marine Corps and other famous rifle organizations. The tradition in this country of the American rifleman cannot be ignored—as a regiment, Morgan's Riflemen were superhuman. There are many other similarly famous units.

The view which obtains in some circles that a semiautomatic rifle is not to be used to deliver accurate single shots, but rather to blast off generally directed volleys, is not founded upon clear reasoning or upon fact. Those semiautomatic rifles which have been adopted are capable of normal rifle accuracy. However, if rapidity of fire is such a serious disadvantage, then we should return to the single-shot arm and give up the magazine weapon.

THE light machine rifle proceeds in a different direction. Provided such an arm can be fired as easily and accurately as a semiautomatic and can be controlled reasonably in automatic bursts, it offers a more versatile weapon than any on the list. A weapon which weighs substantially more than the average rifle (nine to ten pounds), is not, however, entirely mobile. Nevertheless, for some years the U. S. Army and Marine Corps have issued one 16-pound Browning machine rifle to each 8-man squad, and the B.A.R. man has managed to keep up with the rest. The standard British musket of 1775 weighed fifteen pounds. The Redcoats who lugged those guns plus their packs out to Concord and back to Boston in almost a single stretch were rugged, to say the least.

The question of the mortar and grenade as an exclusive weapon can best be discussed by quoting Col. Hermann Foertsch of the German General Staff: "It is true that these weapons, whose projectiles act by means of their explosive effect, are not able by themselves to destroy the enemy or to put him out of action except by a lucky hit, nor have they sufficient penetrative power to pierce even relatively light protection."

The proposal to give some squad members one flat-trajectory type of weapon and the rest one high-angle-fire type of

*Coauthor (with Charles T. Haven): "Automatic Arms," 1942. Captain, U. S. Marine Corps Reserve.

weapon can be disposed of by reëxamining the proposal above as to the best flat-trajectory weapon to choose. The high-angle-fire weapons include the light mortar and the grenade discharger. The choice narrows to one of relative effectiveness versus relative mobility. The light mortar is a more effective weapon and gives the squad more independence. The grenade discharger is a short-range weapon which presupposes adequate supporting barrages from heavier mortars.

LET us now consider the proposal to scramble all the weapons. Such a conglomeration within one squad is obviously unsound. The chief objection is the fact that there would be a great diversity of ammunition and ammunition loading as well as weapons. Of course, the antidote for this is simple: make up uniform squads, each one of which has weapons of the same kind. But again there exists a serious objection—the infantry must have versatile weapons, so organized that the quickest possible coöperation is assured.

The fourth proposal calls for an examination of actual, probable, and possible requirements of the squad. To do this we must have in mind not only a general picture of the squad in normal action, but also a brief picture of the squad in less likely, though none-the-less-important engagements, including both offensive and defensive situations. The squad may perform special missions, and the operations may be on islands, along beaches, in tropical jungles, in northern forests, along rivers, in snowclad mountains, on deserts, rolling plains, treeless pampas, in the middle of cities and towns, in places where the road net is heavy, in places where there are no roads at all.

The squad may be carried within close sight of the enemy in automobiles. Tanks may predominate in one action and may be entirely helpless in another. If the German attack on France was any indication, an infantry squad may find itself miles inside the enemy lines, or rather, to be more exact, deep within enemy defensive combat groups. Our orderly concept of even lines of units, with each class of weapons in just the right place, is dangerously misleading.

German artillery carried rifles in France because often the artillery was firing with French infantry close by. German infantry had plenty of accompanying artillery, some of the guns being mounted on tank chassis.

IT IS submitted that we must simplify the squad armament without seriously impairing versatility. Specifically, we should accomplish the following things: uniform loading, rapid, accurate rifle fire, volume fire, or bursts at longer range, effective enfilading and high-angle fire, close-combat high-angle fire, maximum mobility, and rapid application of fire. Therefore we must make reductions to common denominators, so to speak. First of all, we need two light mortars or two grenade dischargers. Next we must consider what weapons are the most versatile. Regardless of our personal predilection, we must all admit that the light machine rifle leads the rest, with the less mobile light machine gun a close second, and the more mobile semiautomatic rifle a close third. The dangerous limitation on the submachine gun is its short range.

The medium light machine gun may serve excellently as a special squad weapon of the platoon or company; but that is another story. The light machine gun—preferably the light machine rifle—definitely belongs in the squad. The light mortar is not too light. The rifle-grenade discharger or an equivalent 50-350-yard weapon is essential if there is lacking a light mortar effective at 50-150 yards, as well as at ranges up to 300-500 yards. The average light mortar seems better suited to the platoon's special mortar squad. It is not easy to lay the high-angle-fire weapon accurately for ranges over 300 yards without more elaborate mounts than the squad is adapted to employ.

The rifle or semiautomatic rifle, one or the other, are essential to the squad. The trend is toward the semiautomatic arm. The light machine rifle, as well as the light machine gun, may be fired semiautomatically. The light machine rifle can be handled from the shoulder as a rifle; the light machine gun is not well adapted for this purpose. Sniping can be carried out with a semiautomatic having special sights and possibly a telescope.

Suppose we consider a squad to include the following men and their respective weapons: (1) Squad leader, semiautomatic rifle; (2) Second-in-command, semiautomatic rifle; (3) Scout, semiautomatic rifle; (4) Scout, semiautomatic rifle with telescope and special sight; (5) Gunner, light machine rifle; (6) Assistant, semiautomatic rifle; (7) Emergency assistant, semiautomatic rifle; (8) Gunner, light machine rifle; (9) Assistant, semiautomatic rifle; (10) Emergency assistant, semiautomatic rifle; (11) Grenadier, rifle-grenade discharger; (12) Grenadier, rifle-grenade discharger.

THIS squad may be grouped as follows: squad leader, sniper scout, gunner, rifleman (assistant), rifleman (emergency assistant), grenadier, subleader rifleman, rifleman scout, gunner, rifleman (assistant), rifleman (emergency assistant), grenadier.

Riflemen are issued hand grenades. The emergency assistant gunners are used for the light machine rifle chiefly on the defense. The grenadiers may also serve as riflemen at ranges over 400-500 yards if required. (Example: Beach defense, delivering fire on troops landing, or fire on flat, entirely open terrain where high-angle fire is useless.)

The squad armament chiefly consists of 2 light machine rifles, 9-10 semiautomatic rifles, 1 sniper semiautomatic, 2 grenade dischargers, hand grenades (optional issue), 10 bayonets.

In certain situations the squad may be rearranged into two teams, as follows: (1) Squad leader, four riflemen, two grenadiers; (2) Subleader, two gunners, two assistants. Where more intense automatic gunfire of some duration is to be required, as in an extreme defensive situation, another arrangement can be made as follows: (1) Squad leader, two gunners, four riflemen (as assistants); (2) Subleader, two riflemen, two grenadiers.

In this situation, the subleader and four men act as ammunition carriers. The 3-man gun crews on the light machine rifles serve as gunner, loader, and magazine reloader (*i.e.*, refilling empty magazines for insertion by the loader). Barrel changing or cooling is also accomplished by the third member. The squad leader directs the fire of the light machine rifle crews. The subleader's group is responsible for the flanks and protects the light machine rifles from hostile grenadiers, etc. The combined effective fire of two light machine rifles will nearly equal that of one heavy, water-cooled machine gun.

In another aspect, however, the light machine rifles are operated purely as semiautomatic rifles. Automatic fire may not be desired or required. Thus, the squad has the fire effect

CLASS	HEAVY MACHINE GUN	MEDIUM LIGHT MACHINE GUN	LIGHT MACHINE GUN	LIGHT MACHINE RIFLE	SEMI-AUTOMATIC RIFLE	HAND-OPERATED RIFLE	SUB-MACHINE GUN	AUTOMATIC PISTOL	REVOLVER
Weight (pounds)	35	25	20	14	9.5	9	7–8	2.5	2
(Plus mount)	80	35	22	16					
How fired	Tripod only	Tripod or bipod	Tripod or bipod	Tripod, bipod, or shoulder	.....	.....	.....	.....	.....
How loaded	Belt or strip	Belt, strip, or drum	Detachable magazine	Detachable magazine	Clip	Clip	Detachable magazine or drum	Detachable magazine	Singly in cylinder
Limits of effective burst range, flat-base bullets (yards)	1800	1200–1400	1200–1400	1200–1400	.....	.....	300	.....	.....
Accuracy limits, single shots (yards)	Not so fired	600–800	600–800	600–800	600–800	600–800 (1000 with telescope)	100–200	50	50–75
Rates of effective fire (shots per minute)	150–300	100–250	100–200 or 60 semi-automatically	100–150 or 60 semi-automatically	15–25	5–10	100–200 or 50–60 semiautomatically	20	12

CHARACTERISTICS OF FLAT-TRAJECTORY WEAPONS

of twelve semiautomatic rifles. Actually, the light machine rifles have a somewhat greater capacity for semiautomatic fire than the semiautomatic rifle itself.

The sniper should have a specially selected rifle with the best ammunition available. He should be chosen on the basis of marksmanship and scouting qualifications. His telescope should be suited for firing in bad light, as well as for its magnification. The sniper's problem is rather to distinguish targets than to magnify them. The telescope should be easily detachable, iron sights being normally affixed.

The same organization is adaptable to an armament consisting of repeating rifles and light machine guns. As stated above, the medium light machine gun is believed insufficiently mobile for the squad.

HAVING analyzed the various possible choices of weapons for the squad, it is proposed to compare the foregoing conclusions with actual modern trends.

The German squad or *Gruppe* consists of two teams: Four men compose the medium light machine gun crew, seven the rifle team, and the group leader makes the thirteenth; the subleader is with the rifle team. Of the light machine gun team, No. 1 is gunner, No. 2 assistant, No. 3 is rifle-armed, and No. 4 is probably armed with a submachine gun. Numbers 2 and 4 at least carry pistols. The two teams are separated in deployment, the interval rarely exceeding eighty yards. The German medium light machine gun weighs about twenty-four pounds.

An examination of recent German thought indicates the following significant points:

1. Speed of attack depends chiefly upon the individual soldier's mobility. He must be given the lightest weapons practicable; the heavy pack is out. Infantry organization is in a state of flux.

2. The closest concentration of fire, both as to time and space, is characteristic of modern fire tactics.

3. Surprise effect is a decisive factor in gaining fire superiority, and such surprise effect can and should be achieved by all units, including the squad.

4. Fire superiority is gained chiefly by automatic weapons.

5. The squad moves forward as close as possible before opening fire, but since heavy-weapon support in practice fails to cover the squads at ranges closer than 300-700 yards, the squads must have their own independent, self-supporting fires.

6. The riflemen of the squad "cover the enemy with well-aimed rifle fire, in order to break completely his will to resist" (quoting Colonel Altrichter, director of the German Kriegschule).

7. The squad fire from cover and seek surprise effect. They prepare under cover, suddenly bob up, and quickly deliver their fire. "The calm fire action with the rifle is a thing of the past," says Colonel Altrichter. "The modern rifleman must be trained systematically in rapid fire."

8. Teamwork between the light machine gun crew and the rifle team of the German *Gruppe* is admitted to present a difficult problem. Since the light machine gun is limited to fire between gaps, it must not be too far in rear.

Thus it appears that the German group with its separate light machine gun team and medium light machine gun is not entirely satisfactory. Twenty-odd years ago, the heavy machine gun frequently failed to keep close enough to the rifle units to help them. The medium light machine gun today, as a squad weapon found in the rifle platoon organization, seems lacking in mobility.

In this connection the British experience with their 21-pound light machine gun indicates that although the Bren was originally regarded as a "section" (squad) weapon, its lack of mobility as an individual infantryman's weapon caused it to slow down the movements of the riflemen or else to be left too far behind to be of use.

It is significant to note that the British sought a squad weapon; that the 21-pound light machine gun is too heavy as a squad weapon; that the German medium light machine gun also is too heavy as a squad weapon; that the tendency with such weapons is to develop a separate echelon; that such echelons take on a supporting rôle; that the final outcome is to leave the squads to support themselves with rifle fire only—*the very situation it was hoped to avoid.*

The Austrian squad consisted of ten men and a leader. There were two men on the light machine gun, one submachine gunner, one sniper, six riflemen. The Russians have one light machine gun in each 8-man squad, a separate high-angle-fire squad in each platoon. The Swiss have a 13-man squad of two teams, six men in the light machine gun team, six in the rifle team, and a leader. The French Army had practically the same squad organization—six in the light machine gun team, five in the rifle team, including one grenadier, and the squad leader, a total of twelve.

The United States had an 8-man squad, consisting of the squad leader (rifle-armed), one automatic rifleman, a rifle-armed assistant, one rifle grenadier, and four riflemen. The Marine Corps at one time included one submachine gunner in place of one rifleman. The new war-strength U. S. squad is composed of twelve men (peace strength, nine). The light machine rifle (automatic rifle) is found in a separate squad composed of eight—two light machine rifle teams of three men each, a leader and assistant leader. Thus, there are two (three in defense) light machine rifles per platoon of thirty-five to forty men.

A medium light machine gun (a tripod-mounted, belt-fed, air-cooled machine gun weighing about twenty-four pounds, mount about eighteen pounds) is contemplated for the rifle company. This weapon is not designed for shoulder fire.

AS regards the rifle squad, the United States has for some years looked toward the semiautomatic rifle to increase the fire effect of the individual infantryman while not adding unduly to his armament burdens. The current U. S. squad is armed with the Garand semiautomatic rifle, M1. One other government has since followed the U. S. in adopting a semiautomatic rifle for general issue to troops. At the same time, its forces also will be equipped with a light machine rifle some eight pounds lighter than its earlier model light machine gun.

The Japanese emphasize the light machine gun which supports the bayonet-armed Jap riflemen, being the source of most of the platoon fire power. Japs emphasize the bayonet and sword. Rifle fire is incidental, little-emphasized, perhaps because the Japs are not very good riflemen.

The Japanese platoon consists of five 8-man squads, three of which are armed with one light machine gun (22½ pounds) each, the other two with one 11-pound, 56-mm. grenade thrower each. Riflemen make up the balance of each squad.

In general it appears that the trend is toward versatile weapons in the squad. The Germans, British, and French in particular sought to obtain an all-around light automatic for the squad. The U. S. had a light automatic more of the rifle type when the last war ended. The European object was defeated in part by mobility's archenemy, weight. To obtain weapons comparable to the continental types, the U. S. has added mounts to the automatic rifle, recently reduced the weight of the heavy machine gun, and developed the semiautomatic rifle.

From the viewpoint of the foreign military and technical critics, and purely in the spirit of academic criticism, the U. S. weakness is, in substance, that the semiautomatic may unprofitably exhaust the individual's ammunition; that the U. S. automatic rifle, as modified, lacks the removable barrel and convenience of reloading needed in a light machine gun or light machine rifle; that the medium light machine gun (or lightened heavy machine gun, which it really is) is not suited for semiautomatic fire, and lacks the speed of fire application of the European light machine gun or medium light machine gun since it is not adapted for shoulder firing.

European weaknesses already have been indicated in other connections. In comparison, the U. S. automatic rifle can be readily fired from the shoulder and operates quite accurately from the bipod; the U. S. medium light machine gun is modified from a very reliable heavy machine gun. Under some conditions, semiautomatic riflemen can fire intense barrages, about thirty accurate burst-rounds in a minute. Yanks usually make good shots and are good mechanics.

GAZING into the future through the medium of numerous authorities, including Colonel Foertsch and Colonel Altrichter of Germany, and General Lynch and Colonel Phillips of the United States, it appears almost certain that the squad, as well as the larger units of which it is a part, will possess more versatile and more powerful armament and will be designed to operate as independent teams. Moreover, every effort will be made to improve the mobility of the squad when operating afoot.

In the interests of simplicity, the squad needs weapons of the fewest types consistent with versatility of fires. The trend will be toward versatility of fire followed by uniformity of equipment, because it is always quicker and easier to get a variety of special-purpose weapons than to get more uniform, all-purpose or multipurpose weapons. Evolution in one aspect consists of integration.

Suppose there were effectively combined the characteristics of the high-powered light machine gun, rifle, and semiautomatic rifle, together with an optional adapter for projecting rifle grenades. If such a weapon weighed little more than the rifle, we might find in it the answer for the future.

A further feature badly needed is a rifle cartridge capable of piercing light tank armor. The ability of the above squad weapon to fire bullets through an inch of armor up to 300-350 yards would result in giving the squad an ever-ready selection, versatile yet at the same time entirely uniform.

Barring this, it is believed that the more immediate future will show a trend gradually to the semiautomatic rifle and light machine rifle or gun in the squad. Those nations which are able to obtain submachine guns more readily are naturally going to resort to that weapon, which will also prove valuable for special purposes. However, the War Department's new submachine rifle, with its weight reduction of nearly fifty per cent, is likely to shorten the future of the pure submachine gun, especially as a squad weapon.

EDITOR'S NOTE.—Captain Johnson wrote as follows on "Small Arms Ammunition Supply" in the July-August 1940 issue of ARMY ORDNANCE (Vol. XXI, No. 121, p. 41):

"It is interesting to consider the fact that while there has been an increase in 'ammunition-requiring' agencies, there also has been a distinct increase in ammunition-supplying agencies since the World War. Attention is called to the fact that the road nets of the world are many times greater, wider, longer, smoother, straighter; that there are many times more trucks, cars, and similar transportation agencies. In addition, we have the tremendous growth of air transport. Add to these the improved media of communication (radio, etc.), and one must confess the picture is not so black as regards supply of ammunition to rifle units, as well as all other supply not specifically covered herein."

Processing an Ordnance Officer

Beginning Commissioned Service at the Ordnance Training Center

Lieut. Bernard B. Abrams *

ONE of the problems confronted in the expansion program of the Ordnance Department is the procurement of an adequate number of qualified commissioned officers. Although comparative statistics reveal that approximately 7,000 officers are now on duty with the Ordnance Department compared with about 325 officers in 1938, the number is still far from sufficient.

At the Ordnance Training Center, Aberdeen Proving Ground, Md., officer personnel is handled by the personnel section, a part of the S-1 Staff, Headquarters O.T.C. The problem immediately confronting this section is the classification of qualified officers, together with their assignment to suitable positions both in the field and in industry. The personnel adjutant is in charge of the personnel section, aided by an assistant personnel adjutant, the latter officer being in immediate control of the officers' section. There are two commissioned officers and twenty enlisted men in the personnel section at present. Records and files of all enlisted men in O.T.C. headquarters, headquarters detachment, and the 755th Military Police Battalion are kept in this office, in addition to files of commissioned officers.

Ordnance officers are now being secured from the following sources: officers of the Regular Army transferred to Ordnance from other branches of the service; Reserve Ordnance officers; Reserve officers from other branches detailed to duty with Ordnance; National Guard officers; officers appointed directly from civilian life; graduates of the Officer Candidate School (Ordnance); and current R.O.T.C. graduates.

Most of the officers being called to active duty with the Ordnance Department are sent to the Ordnance Training Center in compliance with special orders issued either by The Adjutant General or one of the nine corps-area commanders. Upon arrival at the Ordnance Training Center, these officers are issued an instruction sheet at the information desk on the first floor of the Administration Building where the date and time of arrival of each officer is recorded in the register. The instruction sheet lists the various steps to be followed in the initial processing of an officer. It also cautions the officer to observe the required military courtesies while on an Army post.

Immediately upon reaching the personnel office, the newly arrived officer reports to the personnel adjutant and shows copies of his special orders. An entry is then made in the register of the chief clerk, officers' section, who also issues two copies of the Ordnance officer's qualification card to the reporting officer. These cards are filled out in duplicate at tables provided for this purpose in the office. The information listed on the card includes personal history, schools attended, military service, and civilian experience. After the cards have been completed, one is dispatched to the Office of the Chief of Ordnance in Washington, and the other is placed in the officer's 201 file.

The next step is the execution of prescribed forms, including report of entrance on extended active duty, signature card and certificate for the finance officer, statement of beneficiary, and certificates for the medical officer. The officer is then ready to report to the finance office located on the Proving Ground proper. Those who do not possess their own means of conveyance may utilize the post bus or are furnished transportation by the Quartermaster dispatcher.

Each officer is interviewed by the assistant personnel adjutant, upon return from the finance officer. The purpose of the interview is to become familiar with an officer's training, experience, and aptitudes, and to ascertain for what type of work a man would be best qualified within the Ordnance Department, in harmony with existing vacancies. When the interview has been completed, the officer is sent to the hospital for final-type physical examination, or a physical check-up. Following this, he is required to stand the Army qualification test, given under direction of officers of the Adjutant General's Department. The officer is then assigned to the Ordnance officers' replacement pool. Under normal conditions, the processing of an officer can be completed in one working day.

THOSE assigned to the replacement pool are listed as student officers, and their time is profitably devoted to basic training. The subjects primarily studied are: ordnance service in the field, administration, and military courtesies. Each afternoon for 1½ hours, the officers participate in close-order infantry drill. The above instruction is supplemented with lectures and demonstrations delivered by staff officers, such as the staff judge advocate general, the chemical officer, etc. Each student officer is required to take part in the program of instruction, leading a discussion on some professional subject in which he is proficient.

The instruction for those in the replacement pool is imparted according to the following schedule of hours: weekdays, 8:00 A.M. to 4:30 P.M.; Saturdays, 8:00 until 12:00 A.M. One night each week the pool officers are conducted on a tour of the Ordnance School. Instructors from the Ordnance School are detailed as monitors for the replacement pool, and the ranking student officer in the pool is made responsible for the conduct of drills and accomplishment of the program of instruction. Although an officer may remain in the pool from one day to one month before he receives a permanent-duty assignment, the average length of stay is from seven to ten days.

The officers in the replacement pool represent many varied professions. During one week in April, among sixty officers in the pool the following civilian careers were represented: mechanical, civil, petroleum, textile, architectural, chemical, mining, and industrial engineering; law; banking; accountancy; forestry; merchandising; sales and sales engineering; insurance; drafting; fire protection and safety work; trucking; business executiveship; watchmaking; civilian employment with the Ordnance Department; warehousing; tax collection; highway patrol; farming; high-school and college

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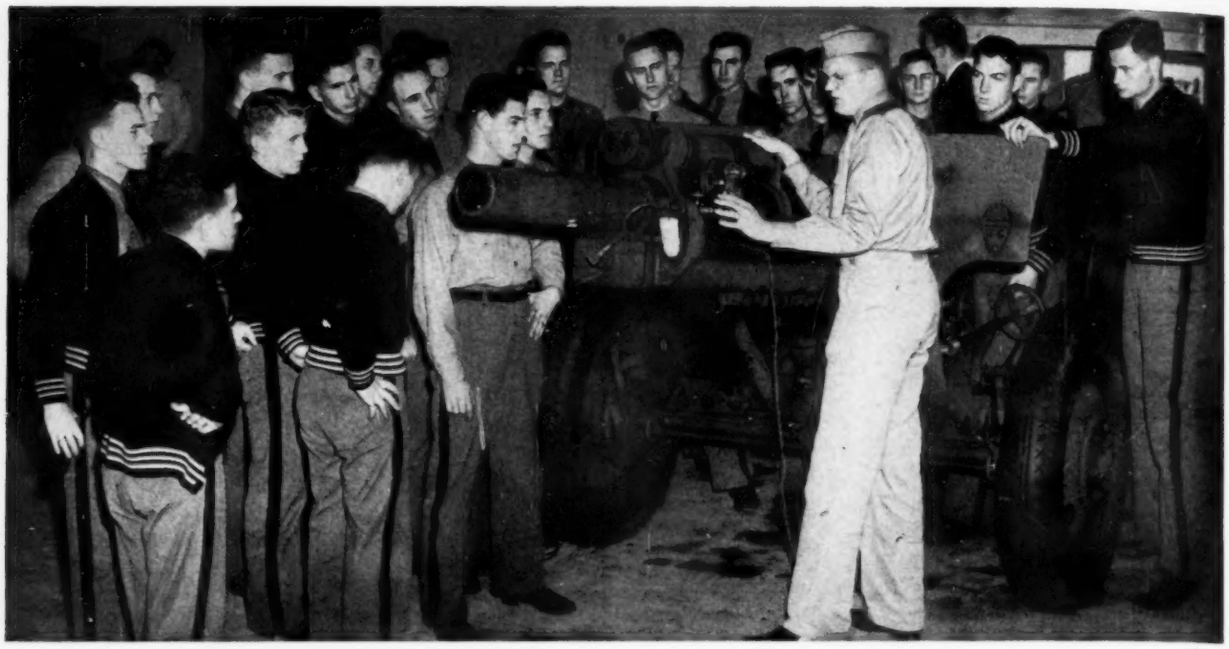

Acme

U. S. MILITARY ACADEMY CADETS INSPECT A 105-MM. HOWITZER AT ABERDEEN

teaching; journalism; investigation. Some young men had been graduated from college only six weeks previously.

Some may wonder, if the Ordnance Department can find places for such a heterogeneous group of men. The answer to such a question would be that there is a place for each man where his past experience may be used to good advantage. For example, lawyers are needed to negotiate contracts and for procurement activities; bankers are valuable for matters of finance; accountants are needed in many places to keep the books; the forester may be an expert on tractor maintenance; merchants may be utilized for supply work and in the post exchanges; salesmen make good liaison officers; men experienced in fire protection are required for plant inspection; business executives usually are excellent staff officers; watchmakers have proved to be invaluable in handling the small and complicated mechanisms of antiaircraft directors, height finders, and fuzes; an optical-lens grinder was well qualified for work on artillery sights; tax collectors and investigators make very good inspectors and property officers; highway policemen were assigned to the Corps of Military Police and to security detachments at arsenals; one farmer solved a problem in soil erosion which prevented the foundation of an arsenal from settling and causing serious damage; teachers are utilized on the faculty of the Ordnance School; newspapermen and journalists fit well into technical report writing and public-relations work; and, of course, technical men are essential in the actual design and manufacture of Ordnance matériel.

In assigning an officer to duty, every effort is made to place him in work for which he is qualified. By doing this he will be most content and able to utilize his past training and experience, thereby being of the greatest value to the country. In making an assignment, the personnel office of the Ordnance Training Center works hand in hand with the Military Personnel and Training Division, Office of the Chief of Ordnance, in Washington. The latter agency notifies the Aberdeen office when vacancies exist, and sets quotas that must be filled. The personnel section, O.T.C., in turn recommends officers of the replacement pool to fill the vacant positions. In every case, clearance must be made through Washington, and final decision as to the disposition of an officer comes from the Office of the Chief of Ordnance.

THE functions of the Ordnance Department are under two main categories; namely, Industrial Service and Field Service. The Industrial Service embraces the design and manufacture of Ordnance matériel, while the Field Service is responsible for the issue and maintenance of this matériel. In the Ordnance Department, just as in all other branches of the military service, officers are classified as being "over age" or "troop age" according to their age and grade. The present policy is to assign none but "over-age" officers to the Industrial Service, and only "troop-age" officers may be assigned to the Field Service. There may be exceptions to the foregoing policy; for example, "troop-age" officers who have been highly trained in chemical processes are sometimes assigned to plants employed in the manufacture of explosives.

In making an assignment, the following points are considered: an officer's civilian and military experience, his education, age, grade, personality and traits of leadership, results of the Army classification test and, finally, the needs of the service. An officer may be assigned to duty directly from the replacement pool without further training, when his experience so justifies. Otherwise, it is customary to assign him as a student to the Ordnance School, or to other educational establishments of the Ordnance Department.

Officers who have been appointed to commissioned rank from civilian life, in recognition of outstanding technical qualifications, are assigned to the Ordnance School as students for an intensive one-month course in basic military training, similar to that taken by officer candidates. This may be followed by specialized instruction in Ordnance, only if time permits or if warranted by a special situation. Current R.O.T.C. graduates are required to pass a prescribed course in the Ordnance School before they may be commissioned and assigned to permanent stations.

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Toward Victory

A Résumé

ON DECEMBER 7, 1941, WHILE DIPLOMATIC NEgotiations were in progress in Washington, the Japanese made a series of surprise air attacks on naval vessels and military and naval installations in and near Pearl Harbor, Territory of Hawaii. These attacks resulted in the loss of many American lives, the sinking of several naval vessels, and serious damage to several others. In addition, a number of Army and Navy combat airplanes were destroyed at various airfields in Hawaii, and many buildings, including barracks, hangars, and repair shops, were wrecked.

While these attacks were still in progress, in accordance with joint plans the Army and Navy took immediate steps to meet the situation. A considerable portion of the Navy was then engaged, as it had been for several months, in convoying American vessels carrying troops and supplies to our outlying bases and supplies to other countries under the provisions of the Lend-Lease Act. The existence of a state of war required a strengthening of these convoys and, in some cases, the use of Army bombers to furnish additional protection.

Shortly after the attack on Pearl Harbor, a large force of Japanese land-based aircraft bombed the Philippine Islands. This attack had been expected in the event of war, and, as a security measure, steps had been taken by the Army to reënforce the Philippine garrison in trained troops and modern matériel prior to December 7th. These reënforcements had been under way since late spring of 1941, and, between August and the outbreak of the war, sizable augmentations in aircraft, modern artillery, and tanks had been sent. Further reënforcements were on the high seas en route when the attack came, and these transports were ordered to alter course for Australia. Proceeding under naval escort, they arrived safely and formed a nucleus for the American forces subsequently dispatched to that country.

We had several small outposts in the Western Pacific which were held by slender defense forces made up entirely of Navy and Marine Corps personnel. These included the islands of Midway, Wake, and Guam. After a gallant resistance, the defenses of Wake were overcome by the enemy. Guam, after a similar gallant defense, also fell into enemy hands. Midway Island still remains in our possession.

Four days after the Japanese attack on Pearl Harbor, Germany and Italy declared war upon the United States. This immediately involved the nation in a conflict global in extent and involving strategic considerations unique in the history of this country. It necessitated the immediate garrisoning on a war basis of outposts extending from Alaska to Australia in the Pacific Ocean and from Iceland to South America in the Atlantic. During the first three weeks of the war, and in conformity with previous plans, approximately 600,000 American troops were moved to battle stations, many of them thousands of miles distant, across the Atlantic and Pacific Oceans, under naval escort, through submarine-infested waters. Others went to our island bases in the Atlantic and Pacific, to the Canal Zone, and to Alaska.

A primary factor in the rapid movement of large numbers of troops and supplies overseas was the functioning of the ports of embarkation which had been established prior to the beginning of the war. Organized for the purpose of expediting overseas shipments, these ports of embarkation were handling, even prior to December 7th, tonnage greater in volume than the vast amount required during the World War. Also, careful staff planning and the efficient coöperation of the entire American railroad system permitted the rapid movement within the United States of thousands of troops by rail from training areas in the central part to strategic points on both coasts. In addition, there existed the urgent requirement of maintaining channels of sea and air communications throughout the world in order that preparations for offensive action could be undertaken.

IMMEDIATELY BECOMING THE FOCUS OF INterest from the American viewpoint, the defense of the Philippine Islands presented a complicated problem. Located upon Japan's doorstep, within bombing range by land-based aircraft from Japanese bases on the coast of China and Formosa, at a distance easily susceptible to movements of large bodies of troops by ship from Japan, the Philippines were placed in a state of virtual siege from the outset under Japanese dominance of the sea and air.

Plans for the defense of the Philippines, which had been revised and kept current from year to year, anticipated that in the event of a war with Japan the islands would be attacked by superior numbers. The American land forces there consisted of a relatively small number of trained American troops and Philippine Scouts augmented by a considerable number of soldiers in the partially developed Army of the

Philippine Commonwealth. The naval force in Far Eastern waters consisted of a relatively small number of cruisers, destroyers, submarines, and auxiliary vessels. The naval strength of the United Nations in the Orient was further depleted during the first few days of the fighting by the loss of the British capital ships PRINCE OF WALES and REPULSE.

Convoyed by a fleet which included capital ships and airplane carriers, the Japanese dispatched a powerful expeditionary force to the Philippine Islands. After several feints and abortive attempts at widely separated points, they were able to land troops in the northern and southern extremities of Luzon. These landings enabled them to seize airfields from which their bombardment and pursuit aviation could operate against our installations. Subsequently, during the dark of the moon and in the face of determined resistance by our defense forces and submarines, the enemy landed in numbers at Lingayen Gulf, northwest of Manila. About two-thirds of the submarines of the Asiatic Fleet were used to oppose these landing operations, and, in spite of strong antisubmarine measures, they succeeding in sinking a number of enemy vessels and troop-laden landing barges. Heavy bombardment aircraft which had been ferried to the Philippines prior to the war also took a heavy toll. It was only by sheer weight of numbers and in the face of heavy casualties that the Japanese were able to land and push back our beach defenses.

Long-standing tactical studies of Luzon indicated the peninsula of Bataan, adjacent to the fortified island of Corregidor, as the terrain most suited for prolonged defense. Although this plan involved evacuation of the city of Manila, the retention of the fortified approaches to Manila Bay denied the use of the Philippines' greatest port to an invader as long as Corregidor held. The operations then resolved themselves into the matter of delaying the Japanese advance to the final defensive position and making it as costly as possible. This movement was skillfully accomplished by the American Filipino forces under General MacArthur's command.

AS THE CAREFULLY TIMED WITHDRAWAL TOward Bataan Peninsula progressed, landing fields for heavy bombardment airplanes became unavailable, and these airplanes were sent to Australia. The Navy bombers were sent to the Netherlands Indies. Although beset with difficulties, these Army and Navy aircraft were able, by operating from the new bases, to continue the support of the Philippines. However, with the enemy in local control of the air, Manila Bay was rendered insecure for ships of any type, and submarines could not be serviced, so Admiral Hart withdrew the remainder of the Asiatic Fleet to the south, leaving behind a few auxiliary vessels and several small, but highly effective, motor torpedo boats.

Covered by the guns of Corregidor and other harbor defenses, the small craft controlled the waters of Manila Bay, and the fast torpedo boats constituted an important element in the Philippine defense by exacting a heavy toll on Japanese shipping. Many of the vessels which were withdrawn to the south were subsequently engaged in the battle of the Java Sea. The few pursuit aircraft which were able to operate from Bataan gave a remarkable account of themselves and on one occasion made a devastating bombing attack on Japanese shipping and installations in Subic Bay, though the planes had not been constructed for this type of operation.

Established in his defensive position on Bataan Peninsula, General MacArthur was able to stabilize his front and beat off repeated and determined attacks which the Japanese made in strong numbers. However, the tightly drawn naval and air screen which the Japanese were able to place around the island of Luzon made delivery of food and ammunition to the American forces difficult. With respect to food, the problem was further complicated by the presence on Bataan of thousands of noncombatants who had moved into the area with the American forces.

In January, the effect of the blockade was felt, the Bataan garrison was placed on half rations, and all necessary steps were taken to conserve the ammunition supply. Determined efforts were made to move supplies to the Philippines from Australia and other places. Some naval vessels and some blockade runners succeeded in getting through with food and ammunition, but for every ship that succeeded in running the blockade, two were sunk by enemy action. As time progressed, the Japanese blockade, operating in central Philippine waters, was so tightened that it became almost impossible to move the supplies accumulated in Mindanao and the Visayan Islands to our beleaguered forces on Bataan.

FOR OVER THREE MONTHS, THE DEFENDERS, reënforced by Marines and bluejackets, held out against every type of onslaught by the Japanese. Fighting side by side, Americans and Filipinos alike met these attacks with a determination and unity of spirit which Japanese superiority in men and matériel could not overcome. Due to heavy casualties and his inability to advance, the enemy was required to move to the Philippines additional combat units which had been scheduled for action elsewhere. With these fresh troops he was able, through the prodigious use of aircraft, tanks, and artillery fire, to keep the weary defenders under constant harassment day and night. Finally, reduced to fifteen ounces of food a day for several weeks, the defenders became so weakened by exhaustion from the heavy fighting and continuous infiltration that they were physically unable to carry through a last desperate counterattack and were overwhelmed. However, small portions of this force were withdrawn to the island of Corregidor during the last hours of the epic struggle.

With the fall of Bataan, the defense of the island of Luzon entered upon a final phase. Corregidor and the other island forts at the entrance to Manila Bay were subjected to continuous air and artillery attacks. Corregidor was bombarded day and night by enemy aircraft and by hostile batteries from the north and south shores of Manila Bay. The morale of the defenders was high, and Corregidor was held with the same grim determination as was Bataan. However, the devastating artillery and air attacks, combined with a shortage of food and ammunition, sealed the fate of the brave garrison. The enemy, on the night of May 5th, made a successful landing attack, and after several hours of savage fighting the forts capitulated.

The defense of the Philippines will stand as an epic of the fortitude and tenacity of the American soldier and his Filipino brother-in-arms. From a practical viewpoint, it demonstrated the comparative weakness of the Japanese as an individual fighter. This feature alone forbodes disaster for the enemy Japanese in the future when the battle is met on terms approaching equality.

An outstanding feature of the defense of the Philippines has been the fortitude and gallantry of the Filipinos them-

selves in the defense of their homeland. The singular bravery with which not only the soldiers, but the entire Filipino people, have conducted themselves in this time of trial has been a constant source of admiration for the American soldiers and the entire American nation.

The Japanese attack on Pearl Harbor, December 7, 1941, transformed overnight the American outlook with respect to world affairs. In fact, at the time of the Japanese attack, our announced purpose was hemisphere defense, and only Regular Army troops, which constituted a small proportion of our growing military establishment, were permitted by law to be moved outside the Western Hemisphere, except to our own territory. In engaging in an amphibious war, worldwide in extent, tremendous distances, both by air and by sea, immediately become a primary factor. The American concept of conducting a war always has been and will continue to be offensive in nature. Sound military policy requires the concentration of all available resources on a main effort with the maximum economy of forces in secondary theaters. This situation may result in apparent reverses which are, within the large strategic picture, actually successes.

DURING THE PREPARATORY PHASE FOR OFfensive action, both the Army and the Navy have carried out a number of successful thrusts which will have a lasting effect upon the strategic situation. The Navy has conducted spectacular raids on Japanese installations and shipping in the Marshall and Gilbert Islands, at Wake and Marcus Islands, and in the Lombok and Makassar Straits. In this latter action against numerically superior enemy forces, various units of our Asiatic Fleet disrupted a large-scale landing operation on the coast of Borneo, sinking many transports and damaging a number of enemy war vessels, with no loss of ships and only minor injuries to our personnel. Combined American and Australian land-based air forces participated in a highly successful joint operation which severely crippled Japanese shipping and shore facilities at two ports on the island of New Guinea. The Army Air Force has carried out raids on Japanese shipping and on shore installations in the Philippines, the Netherlands Indies, the Bay of Bengal, and the Japanese homeland itself, while our submarines in the Far East and in the Southwest Pacific have repeatedly struck at the enemy, damaging and sinking many naval vessels, merchant ships, and transports. In Burma, Chinese forces under the command of Lieutenant General Stilwell upset the Japanese timetable in that area.

Early in May, a task force of the Pacific Fleet, assisted by Army reconnaissance planes and bombers and several United Nations' naval units, engaged a Japanese naval force in the Coral Sea. Severe losses were inflicted on the enemy, and what appeared to be an attempt at further invasion ended in a withdrawal of the enemy forces.

A most encouraging feature since the beginning of the war has been the rapid manner in which machinery has been established for the efficient prosecution of the war. This commenced with reorganizational changes within both the Army and the Navy, progressed through closer coördination of joint operations between the Army and the Navy, and reached its peak in machinery established for close collaboration among the United Nations. Both the War and the Navy Departments have been reorganized since December 7th with a view to eliminating delay and expediting administrative procedure.

In the War Department, the War Department General Staff has been materially reduced in size, and most of its administrative duties have been transferred to other divisions. The heads of the three major divisions of the Army—the Army Air Forces, the Ground Forces, and the Services of Supply—report directly to Gen. George C. Marshall, the Chief of Staff, and relieve him of an enormous burden of administrative duties. Similarly, the reorganization of the Navy Department has combined the office of the Chief of Naval Operations with that of the Commander in Chief of the U. S. Fleet. This position of highest naval command is held by Adm. E. J. King. The Chief of Staff, U. S. Fleet, and the Vice-Chief of Naval Operations, acting directly under the Commander in Chief, relieve him of many administrative duties.

ON ALL OF OUR FAR-FLUNG BATTLE FRONTS, the Army and the Navy are coöperating to the closest possible degree. The principle of unity of command has been put into effect in every theater of operation. In the Southwest Pacific, General MacArthur has been placed in supreme command of the land, air, and sea forces of the United Nations. In the Pacific area, military and naval forces are under the command of Admiral Nimitz, commander in chief of the Pacific Fleet. In the Panama Canal and the immediately adjacent areas, the Army has control of military and naval forces. In the Eastern Caribbean, all military and naval forces are under the Navy. In the defense of the Atlantic and Pacific coastal frontiers, the efforts of the Army and the Navy are completely unified.

With respect to collaboration among the United Nations, tremendous progress has been made as compared with the World War. Three weeks after the beginning of the present conflict, in conjunction with a visit of the Prime Minister of England and leading members of the British Army, Navy, and Air Forces in Washington, machinery was established to insure complete unity of purpose on the part of the nations concentrating their efforts on the defeat of the Axis powers. The existing machinery also permits collaboration with the members of the British Commonwealth and other powers which have dedicated their efforts to this purpose.

During the first six months of American participation in the war we have met reverses and have enjoyed some successes, but the unity of purpose of the American people and their grim determination to avenge Pearl Harbor and rid the world of militaristic aggressors cannot be denied. They will, in the end, prove the righteousness of the cause to which the United Nations have dedicated themselves.

The high morale of our fighting forces is epitomized in the remarks of Secretary of War Stimson in an address delivered at Harvard University on June 11th: "In courageous spirit they will be the equal, while in thoroughness of training and completeness of equipment they will be superior to any American Army which has ever left our shores. And that is a high comparison. To conform to our historic standards, an American Army must be magnificently brave without becoming brutal; it must be supremely self-confident without becoming arrogant; and it must carry the momentum of irresistible might without losing its faith in individual liberty. They will win, but for that victory will be needed all that they can give. They will also need all that we can give to them, not only in material support—which is comparatively easy—but, far more, by our faith in the spiritual values involved in this conflict and our unity of national purpose in support of those values."

Association Affairs

MAJ. GEN. LEVIN H. CAMPBELL, JR., CHIEF OF ORDNANCE

MAJ. GEN. LEVIN H. CAMPBELL, JR., who has succeeded Maj. Gen. C. M. Wesson as Chief of Ordnance of the Army, is a charter member of the Army Ordnance Association and one of its most ardent supporters. He has contributed frequently to the pages of this journal through many years. During the past four years he has been in charge of the construction and operation of new facilities for the Ordnance program and has achieved phenomenal results in bringing about an adequate supply of those noncommercial items of ordnance for which an entire new industry must be created in time of war.

General Campbell was born in Washington, D. C., on November 23, 1886. He was graduated from the United States Naval Academy June 7, 1909. On December 2, 1911, he was appointed a second lieutenant, Coast Artillery Corps. General Campbell was promoted to first lieutenant on July 1, 1916; to captain on May 15, 1917; to major (temporary) on May 11, 1918; to lieutenant colonel (temporary) on October 10, 1918. He reverted to his regular rank of captain on March 15, 1920, and was promoted to major July 1, 1920; to lieutenant colonel August 1, 1935; to brigadier general (temporary) on October 1, 1940; and to major general (temporary) on April 1, 1942. He became major general (permanent), Chief of Ordnance, June 1, 1942.

General Campbell first served at Fort Monroe, Va., followed by duty at Fort Williams, Maine, until the autumn of 1915, when he was ordered to the Panama Canal for duty with Coast Artillery troops. He returned to the United States in April 1918, and was ordered to duty in the Office of the Chief of Ordnance in Washington, D. C. In September 1920, he was ordered to Stockton, Calif., for the study of artillery-matériel production. He remained at Stockton until the summer of 1921 when he was transferred to the Ordnance Department and served to September 1923 at Aberdeen Proving Ground, Md., as a proof officer in charge of tanks, tractors, self-propelling mounts, and mobile artillery. He then became officer in charge of the design section at the Rock Island Arsenal, Ill.

In April 1926, General Campbell was ordered to Washington, to take charge of the automotive section, Artillery Division, Office of the Chief of Ordnance, remaining on this duty until June 1930. He returned to Rock Island Arsenal as officer in charge of manufacture, serving to June 1935, when he was ordered to the Frankford Arsenal, Philadelphia, Pa., where he had charge of the artillery ammunition department until the summer of 1940. He was then ordered to Washington, for duty in the Office of the Chief of Ordnance, as assistant chief of Industrial Service in charge of new facilities. On October 1, 1940, he was placed in charge of development of facilities, Office of the Chief of Ordnance, Washington, D. C. On January 5, 1942, he was placed in the Industrial Service, which office he held until he became Chief of Ordnance.

ORDNANCE ADVISORY STAFF

GENERAL CAMPBELL'S first official act as Chief of Ordnance was the announcement that four of the nation's prominent business leaders will serve as a volunteer advisory staff. They are: K. T. Keller, president, Chrysler Corporation, Detroit; Bernard M. Baruch, chairman of the War Industries Board in the World War; Benjamin F. Fairless, president, U. S. Steel Corporation; and Lewis H. Brown, president, the Johns-Manville Corporation, New York City.

General Campbell, who will be in direct charge of the $30,000,000,000 program for procurement and supply of the Army's fighting tools, said his appointment of the members of his advisory staff "emphasizes the importance of industry's job in our great armament effort."

Members of General Campbell's advisory staff were among a group of guests who were present on June 1st when the oath of office as Chief of Ordnance was administered General Campbell by Col. I. A. Duffy of the Judge Advocate General's Department. The ceremonies were held at the new Ordnance headquarters in the Pentagon Building, Arlington, Va. The Hon. Robert P. Patterson, Under Secretary of War; Donald M. Nelson, chairman, War Production Board; and Brig. Gen. W. D. Styer, Deputy Chief of Staff, Services of Supply, all were present to felicitate the new chief.

GENERAL BURNS RETAINED AS CHIEF OF MUNITIONS ASSIGNMENT BOARD

MAJ. GEN. JAMES H. BURNS, whose appointment as Chief of Ordnance of the Army was announced in the last issue of this journal, will remain in charge of the Munitions Assignment Board of the United Nations instead of assuming the duties of Chief of Ordnance as announced. General Burns' appointment had already been confirmed by the Senate of the United States, but it was withdrawn at the request of Lease-Lend Administrator Hopkins who asked that General Burns' services in his present assignment of great responsibility be not changed.

All who know General Burns and his long Ordnance service will regret that he is thus deprived of what is naturally the lifelong ambition of every Ordnance officer. None has a greater sense of duty than he, and he thus furnishes another evidence of that high soldierly quality in adhering strictly to his assigned duties even at the sacrifice of great military honor.

CHICAGO DISTRICT ADVISORY BOARD

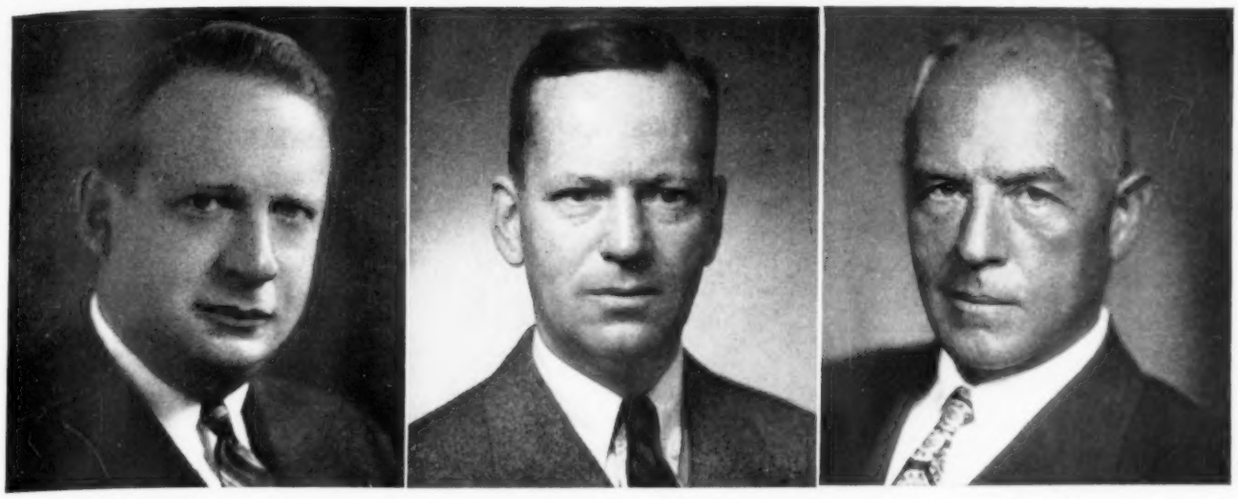
THREE prominent Chicagoans, all with experience in World War I and specialists in the fields of purchasing, production, and legal procedure, comprise the advisory board of the Chicago Ordnance District. They are Brig. Gen. Thomas S. Hammond, I.N.G. (Ret.), James F. Oates, Jr., and Henry P. Isham.

General Hammond, production specialist of the board, has been associated with the manufacturing industry throughout his lifetime. He resigned as president and general manager of the Whiting Corporation, Harvey, Ill., to join the staff of the Chicago District. Born in Crown Point, N. Y., on October 29, 1883, General Hammond attended high school in Chicago and then went on to the University of Michigan to study law.

In 1915 General Hammond joined the Illinois National Guard as a private. He served with this unit on the Mexican Border in 1916 and while there was commissioned first lieutenant. He was later promoted to the rank of captain of artillery and went to France as a member of the Rainbow Division. While in France he was promoted to major and then to lieutenant colonel, the rank he held when he was honorably discharged in March 1919.

After returning to civilian life, General Hammond continued to take an active part in the Illinois National Guard and was commissioned a colonel in 1921. In 1924 he attended the Army War College in Washington, and in November 1931 he was commissioned brigadier general of the line in command of the 65th Infantry Brigade, I.N.G. He was transferred to command of the 66th Infantry Brigade in 1933 and maintained this command up until the time he retired from active participation in the Illinois Guard in May 1940.

Filling the rôle of legal adviser and chief of the contract service division of the Chicago Ordnance District is James Franklin Oates, Jr., well-known Chicago attorney. Mr. Oates is a native son of the Chicago area, having been born in Evanston on No-



James F. Oates, Jr. *Henry P. Isham* *Brig. Gen. T. S. Hammond*

MEMBERS OF THE ADVISORY BOARD, CHICAGO ORDNANCE DISTRICT

vember 11, 1899. His prep school days were spent at Phillips Exeter Academy, and after his graduation he entered Princeton University where he received his A.B. degree in 1921.

Like thousands of other young men of his day, Mr. Oates' college career was interrupted by the World War. He entered the Army as a private and was later promoted to a second lieutenant of infantry, serving as a machine-gun instructor at Camp Hancock, Augusta, Ga.

After being graduated from Princeton, Mr. Oates returned to his home town to continue his education at Northwestern University. He received his law degree from this institution in 1924 and promptly became associated with the legal firm of Cutting, Moore & Sidley of Chicago, being made a partner in 1931. Upon joining the advisory staff of the Chicago Ordnance District in the latter part of January, Mr. Oates terminated his legal connections.

Henry P. Isham, president of the Clearing Industrial District of Chicago, is chief of purchasing of the Chicago Ordnance District. Mr. Isham has been associated with the Clearing Industrial District since 1919 and has been that corporation's president since 1926.

Mr. Isham obtained his elementary and preparatory school education at the Chicago Latin School and Hill School, Pottstown, Pa. He was graduated from Yale in 1917 and soon afterward entered the first officer's training camp at Fort Sheridan. Upon receiving his commission as a second lieutenant he stayed at the camp as an instructor. The following year he went overseas as captain in Battery D, 331st Field Artillery. He was discharged from the Army in February 1919 and upon returning to Chicago began his career with the Clearing Industrial District.

Rocky Mountain Post

MAJ. GEN. LEVIN H. CAMPBELL, JR., Chief of Ordnance, was the guest and principal speaker at the inaugural ceremonies of the Rocky Mountain Post, Army Ordnance Association at Denver, June 10, 1942. It was General Campbell's first appearance before the society as Chief of Ordnance. The ceremonies marked the formation of the nineteenth local chapter of the Association. More than 500 members and guests were assembled in the Lincoln Room, Shirley-Savoy Hotel, Denver, for the dinner which preceded the inaugural ceremonies. L. Ward Bannister, prominent Denver attorney, past president of the Denver Chamber of Commerce and a director of the Chamber of Commerce of the United States, was the toastmaster. The meeting was sponsored by the Manufacturers Association of Colorado with the coöperation of the Denver Chamber of Commerce and other organizations. Capt. James Colasanti, temporary chairman of arrangements, was in charge of the meeting.

General Campbell spoke in praise of the industry and natural wealth of the Colorado area. He emphasized the growing place which Colorado holds in the Ordnance production program and urged renewed vigor on the part of all members of industry in the successful conduct of the Ordnance responsibilities which lie ahead.

The charter of the new post was presented, on behalf of Brig. Gen. Benedict Crowell, president of the Association, by Lieut. Col. L. A. Codd, executive vice-president, who also described the functions of the national organization, its history, and present status.

Heading the local committee on arrangments for the inaugural meeting were W. A. Maxwell, Jr., president, Colorado Fuel and Iron Corporation; John G. Gates, vice-president, Gates Rubber Company and president of the Manufacturers Association of Colorado; Newell H. Orr, vice-president, Colorado Fuel and Iron Corporation; Allan T. Flint, secretary-manager of the Manufacturers Association of Colorado, and Captain Colasanti.

Milwaukee Post

BRIG. GEN. G. M. BARNES, assistant to the chief of the Industrial Service, Ordnance Department, in charge of engineering and research, was the principal speaker at the largest meeting in the history of the Milwaukee Post which was held at the Hotel Shroeder, Milwaukee, on the evening of June 4, 1942. Col. William W. Coleman, president of the Post, presided.

General Barnes emphasized the place which private industry holds in the present Ordnance undertaking not only from the standpoint of production but especially in the fields of research and design. He told of the many committees of private industrial producers now at work on ordnance manufacture who have done yeoman service in designing many of our Army's latest weapons. He called special attention to noteworthy developments in the field of heavy weapons by manufacturers in Wisconsin, many of whose executives were present at the meeting.

Fred A. Preston, chief of the Chicago Ordnance District, of which area Milwaukee is now a regional division, described the work of the Ordnance district which now ranks first in money value of ordnance orders in production. Lieut. Col. L. A. Codd, executive vice-president of the Association and editor of ARMY ORDNANCE, reported to the meeting on the scope, activities, present status, and future responsibilities of the society. Frank O. Wyse, secretary of the Milwaukee Post, was in charge of arrangements for the meeting.

WASHINGTON POST

THE Washington Post held its final meeting of the season at a luncheon in the Press Club, May 25, 1942, in honor of Maj. Gen. C. M. Wesson, retiring Chief of Ordnance. Maj. Gen. Levin H. Campbell, Jr., General Wesson's successor in that office, spoke in tribute to the guest of honor, while Brig. Gen. H. C. Minton, the principal speaker, described the high lights of General Wesson's career. General Minton has served as executive officer to General Wesson during the past four years. Over 300 members of the Post and their guests were in attendance.

CHICAGO POST

THE annual meeting of the Chicago Post, Army Ordnance Association, was held May 7, 1942, in the ballroom of the Palmer House, Chicago. The toastmaster was Edmund A. Russell, president of the Post and former chief of the Chicago Ordnance District. The speaker was Brig. Gen. Donald Armstrong, deputy chief of the Ordnance district. The meeting was dedicated to the men who managed the Chicago Ordnance District during the World War and to those who, twenty years ago, established the Ordnance district system. Upon their experience, labors, and plans was built the enormous production of today's Chicago Ordnance District. While this annual luncheon was in progress, simultaneous meetings were held in each of the cities where suboffices of the Chicago Ordnance District have headquarters. At each luncheon, General Armstrong addressed the group through the medium of electrical transcription.

LEHIGH-BETHLEHEM POST

THE annual spring meeting of the Lehigh-Bethlehem Post of the Association was held at Allentown, Pa., April 24, 1942. The principal speaker was Lieut. Col. B. S. Mesick, former professor of ordnance in the Department of Military Science and Tactics at Lehigh and the organizer of the Lehigh-Bethlehem Post over two years ago. Lieut. Col. L. A. Codd, executive vice-president of the Association, also spoke. Howard Donohoe, president of the Post, presided at the dinner and introduced Dr. C. C. Williams, president of Lehigh University; Col. F. W. Brabson and Lieut. Col. Arthur F. Bowen of the Department of Military Science at Lehigh; and Samuel Gladding of the Bethlehem Steel Company. Associated with president Donohoe in conducting the meeting was a committee of student members of which John Van Blarcom was chairman.

ORDNANCE SCHOLARSHIP AWARDS

THE Army Ordnance Association annually awards gold scholarship keys to those junior and senior students in R.O.T.C. Ordnance Units who accomplish outstanding work in Ordnance subjects. The following awards have been presented for the past scholastic year:

At University of California, scholarship keys were presented, in the senior year, to George Douglas Gould, of Berkeley, Calif., who majored in chemical engineering; the junior year award was to Walter Pollard, of Tracy, Calif., who is majoring in chemistry.

At Cornell University, the scholarship key for the senior year was won by Richard W. Eustis, of Birmingham, Mich., a student in the Chemical Engineering School; the junior-year award was won by B. J. Walker, of Erie, Pa., a student in the Sibley School of Mechanical Engineering.

At Lehigh University, the scholarship key was won by Robert John McGregor, of Dunmore, Pa., a senior in chemical engineering. Lewis Friedman, of Belmar, N. J., a student in the College of Arts and Sciences, won the Ordnance award for junior year.

At Massachusetts Institute of Technology, the senior award was won by Warren W. Twaddle, and the junior award by Frank E. French.

At University of Michigan, the Ordnance scholarship key was awarded to Verne C. Kennedy, Jr., of the senior class, and to Charles M. Thatcher, of the junior class.

NECROLOGY

THE Army Ordnance Association records with special sorrow the deaths of two of its members, M. Lynn Patterson and Frederic Blin Vose, who have contributed in exceptional ways to the advancement of ordnance design and manufacture. Both were officials of the Sperry Gyroscope Company, and both died in an airplane accident at Salt Lake City on May 2nd.

Mr. Patterson joined the engineering staff of the Sperry Gyroscope Company on March 12, 1917, a few years after his graduation from the Carnegie Institute of Technology. His first assignment with the company was on a project for increasing the range of torpedoes. This work was successfully completed when he established a record for the longest run ever made by a torpedo. He then worked on a secret project for automatically steering airplanes and was the designer of one of the first gyroscopic devices ever installed in an airplane for purposes of automatic steering.

Early in 1918, Mr. Patterson was put in charge of searchlight engineering, and his first important assignment in this department was the design of a 60-inch antiaircraft searchlight for the U. S. Army. This searchlight played an important part at the front during the latter part of 1918 and was considered the most efficient in use by any of the armies.

For the next ten years, Mr. Patterson was chief searchlight engineer. During this time he made many improvements on the searchlight and collaborated with the Post Office Department in setting up the first night air-mail route in the United States. He personally supervised the installation of the first large airway beacons which were installed across the plains from Chicago to Cheyenne. The success of this night air-mail operation won for the Post Office Department the Collier Trophy for 1923. He was also in charge of the development of the modern antiaircraft searchlight which the U. S. Army adopted as their standard.

Mr. Vose was born in Houlton, Maine, in 1901. He was graduated from the U. S. Naval Academy in the class of 1922. As a midshipman he received the Victory Medal for World War service. Mr. Vose left active duty with the Navy in 1926 and went into business in Houlton.

In 1935 he joined the Sperry Gyroscope Company as a technical writer. His extraordinary interest and ability in connection with complicated fire-control equipment enabled him to progress rapidly through various departments of the company until, in February 1940, he became aëronautical sales manager. His efforts toward the development of aëronautical fire control and its introduction have served this country well. Many items of fire-control equipment in use by our military air forces today are the result of his determination, knowledge, and ability.

NOTICE also has been received of the death of the following members of the Association: C. G. Beadenkopf, Wilmington, Del.; T. B. Clark, Washington, D. C.; J. E. Daily, Chicago, Ill.; Lieut. Col. A. J. Davis, St. Louis, Mo.; Maj. Gen. Erland F. Fish, Brookline, Mass.; Alex. Glass, Wheeling, W. Va.; Gus A. Goesele, New York, N. Y.; Hobart S. Johnson, Madison, Wis.; Gosta Lofberg, New York, N. Y.; I. B. Merriam, Chattanooga, Tenn.; C. B. Notle, Chicago, Ill.; H. B. Ohmer, Dayton, Ohio; W. J. Pearmain, Racine, Wis.; L. S. Peregoy, Milwaukee, Wis.; Col. A. E. Schoonmaker, Berwick, Pa.; Benjamin L. Winchell, New York, N. Y.; William E. Woodard, New York, N. Y. To their relatives and friends, ARMY ORDNANCE, on behalf of the Association membership, extends condolences.

Ordnance in Review

THE MACHINE GUN—A PERIOD OF EVOLUTION, PART II

LIEUT. COL. CALVIN GODDARD

WHEREAS the Andrews "Flying Battery" (See Part I) may have epitomized the acme of impracticability, there was another invention then materializing which might well have drawn second prize. Witness the "Improvement in Battery Guns" devised by William Douglass, of Corry, Pa., and patented by him (No. 43,903) on August 23, 1864. This phenomenal contrivance embodies a round metal faceplate mounting four parallel rifled barrels, only two of which are designed to be in firing position at the same time. (The idea was that when one pair became heated from firing, the second could be brought into place and the first allowed to cool.) Behind the faceplate is another circular iron disk or plate, pierced with two rows or sets of cylindrical apertures (chambers), radially disposed and numbering sixteen each, one set ringing it close to its periphery, the other clustered about its axis (Fig. 5). A manually actuated lever rotates the rear disk in such manner that the inner circle of chambers may be brought successively into position directly behind one of the two functioning barrels, those of the outer following a like sequence in respect of the second barrel. Two hammers, one for each set of chambers, are so positioned that they rise and fall by the camming action of a ratchet ring on the chamber plate, discharging successively the contents of the two rings of chambers as these come into alignment with the barrels through which they are to pass.

The entire operating mechanism of this weapon is mounted on a stout iron frame to either end of which are hinged identically similar frames (B' and B''). It will also be noted that provision is made to allow each of these latter to swing through a 90-degree arc, forming, when B' and B'' are at right angles with the front frame, a 3-sided armored enclosure or, when all three plates are parallel, an extended line of iron frames or shields. And the specifications reveal that (though not shown in the drawings) B' and B'' are intended to mount barrels, disk magazines (designated "cylinders," by the inventor), and firing mechanisms duplicating exactly those carried on the front frame. Thus the complete installation as envisioned by Douglass mounted no less than three 2-barreled machine guns, each capable of discharging some thirty-two rounds before reloading. As to its mode of employment, we may quote from the specifications:

"This firearm may be constructed of any desired number of cylinders and barrels, all made to operate as described, and the same may be placed on wheels for field operations, or may be stationary for fortifications, while the whole can be inclosed in bullet-proof armor and one machine operated with two or three men. This machine can be so arranged that the middle section can fire in front, and the side sections at any desired angle, as the three sections are constructed alike, operated the same, as heretofore described."

When all the chambers in a cylinder had been emptied, it was removed, laid in a horizontal position, and a spare magazine, made of wood or metal, of identical diameter and pierced with as many chambers, similarly distributed, laid upon it in such manner that the chambers of both registered, one with another. The two were now placed in a metal frame and a third plate, equipped with pins instead of chambers, laid atop the loaded magazine. By pressure with a hand lever, this uppermost plate was now pressed downward, its pins entering the chambers in the magazine disk, driving their contents down into the cylinder proper. Providing a large supply of these reserve magazines was available, a great many rounds could be discharged before the ammunition supply became exhausted. But a better gun—Gatling's—was already being manufactured in quantity when the Douglass patent was recorded, and history's pages are painfully silent as to the further progress of the latter.

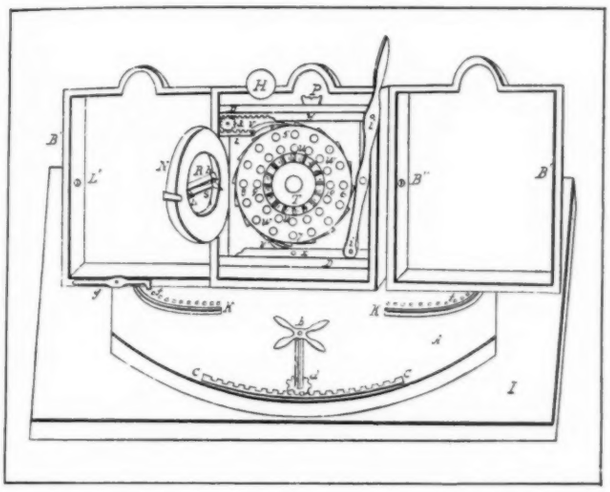


FIG. 5. THE DOUGLASS MACHINE GUN (REAR), 1864

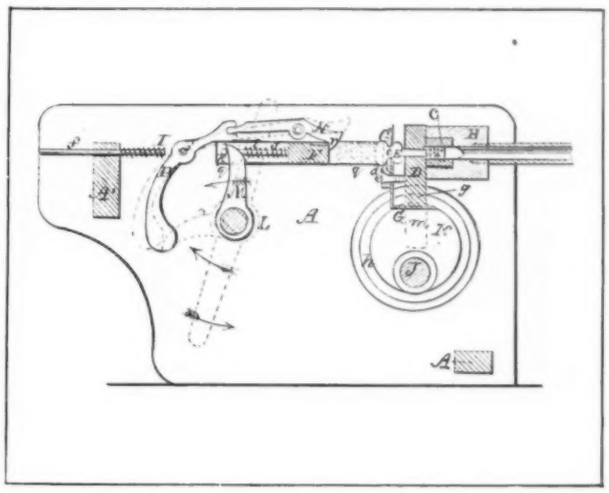


FIG. 6. THE BRETT MACHINE GUN, 1864

One more contemporary device merits brief mention. This was patented (No. 42,552) on May 3, 1864, by James Brett, of Matteawan, N. Y., and resembled in considerable measure the gun of Billinghurst and Requa (Fig. 6). For it possessed a horizontally disposed set of parallel rifled barrels, all to be discharged simultaneously and reloaded at a single operation, in the present instance, not by a "strip" of cartridges, but by a "chamber block" carrying as many loads as there were barrels and positioned to register severally with these. But it was heavier and more complicated than its prototype, slower in loading, and, if the patent drawings are intended to represent the finished piece, possessed a cartridge capacity of but six rounds as against twenty-five for the Billinghurst. So Mr. Brett, faced with another weapon, of the same general type as his own, already in being and exhibiting definite marks of superiority, appears to have folded his tent and made a quiet exit from the military picture. (*To be continued.*)

EDITOR'S NOTE.—The first article of this series was published in the May-June 1942 issue of ARMY ORDNANCE (Vol. XXII, No. 132, p. 976). Other installments will follow.

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Professional Digest

Rubber Mountings in Our Fighting Craft

IT IS the obligation of each American to do his part in allocating every ounce of rubber for use in only such articles as will serve a definite part in winning this war. We cannot overemphasize the necessity of airing this subject and scrutinizing carefully the function of each bit of rubber vulcanized into a finished part.

Take for instance the fraction of one per cent of our rubber used for what are commonly called "rubber mountings." It is a known fact that these are favored with preference ratings when used in our land fighting vehicles, as well as combat ships and military aircraft. Do we incorporate rubber mountings in such equipment so that our service men may enjoy the degree of quiet and freedom from vibration that is becoming common in our "streamlined" civilian existence? Is it for purposes of morale?

First let us consider military vehicles used on land. Take, for example, tanks in which engines, generating plants, transfer cases (gear boxes), radiators, instrument panels, radios, and compasses are supported by rubber. Entirely discounting vibration and noise isolation, all these rubber-mounted pieces of equipment have to be protected from damage due to shocks. The operator and crew depend on the accurate functioning of radios and instruments for continuous dependable travel and precise deadly combat in the field; this entails not only shock absorption but isolation of this delicate equipment from vibratory effects set up by the high-output engines. Under the heading of "shocks" there are effects due to negotiating extremely rough terrain, impacts caused by shells hitting tanks, and disturbance set up by the firing of guns which are mounted on the tank. Besides this, the units mentioned above require provision to accommodate structural twist in the vehicle without setting up any strain in the mounted mechanical equipment (this situation is even more conspicuously evident in the case of trucks, wherein protection rendered by flexible mountings has actually enabled substitution of frames with reduced stiffness). But perhaps a tank is not the proper equipment to consider if one attempts to discount the importance of vibration and noise isolation, since operator fatigue is necessarily a major problem anyway due to the high temperatures experienced and the generally extreme conditions of operation.

The rubber mounting of equipment in marine service is used to (1) isolate engine vibrations from the hull and delicate equipment, (2) protect delicate equipment from any vibrations conducted through the hull, (3) protect this equipment from shocks (such as depth charges, rough seas, etc.), and (4) isolate all disturbances of auxiliary equipment or controls from the hull. The importance of (2) and (3) is as clear-cut as was cited in the previous paragraph in the case of antishock mounts for tanks. The conditions described under (1) and (4) become critical in naval craft in that any such vibrations existing in the hull are in turn conducted through the water and can be picked up by enemy listening instruments. By vibrations transmitted through the hull it is possible for the enemy to locate the position of vessels not within vision, especially submarines. In the face of these considerations, the necessity for rubber mountings becomes apparent before any mention is made of vibration or noise isolation along "æsthetic" lines. Moreover, it is a fact that the "unpleasantness" of vibration, particularly in large vessels, does not rise to the spectacular proportions experienced in land vehicles or aircraft.

The entire situation in the case of aircraft is unique in that

the equipment is designed around its rubber-mounted engines. The entire structure, patterned along the lines of efficient material utilization, has been lightened to the fullest extent rendered possible by the ability of rubber engine mountings to reduce vibration transfer and the consequent fatigue effects. In contrast to this condition, the presence of resonant vibration could lead to structural failure at critical operating speeds in a manner similar to the destruction of the Narrows bridge at Tacoma, Wash., when pulsations in the wind brought about "sympathetic" vibration at the "natural frequency of vibration" of the bridge. The antivibration and shock mounting of delicate instruments and radios is particularly important in aircraft service because the pilot depends on such equipment for every phase of his navigation and military operations, and any inaccuracies in function of the equipment are magnified by the high speeds of aircraft travel. Moreover, the intricate equipment used in this service represents an unusually great monetary investment. As for personnel fatigue, this factor cannot be discounted in 1942 when heavy bombers are being developed which will stay aloft for as much as 7,000 miles of flight.—*Paul C. Roche.*

ORDNANCE PLANT SAFETY

IN ORDNANCE shell-loading plants, the operations of the safety division are of major consequence, for without safety, based on certain rules and regulations, production cannot be successful. A well-operated safety organization functions in all sections of shell- and bomb-loading operations; it enters the engineering, construction, and educational training procedures.

One of the greatest problems in organizing a trained staff of employees to do piece work in loading and assembly is to enable them to conquer the feeling of fear. Past experiences of loading plants that made newspaper headlines because of accidents or major disasters definitely cause the imagination of new trainees to run wild. However, the feeling of fear can be outwitted and the employee taught that the safest way in loading operations is the only way—the right way.

In recent years, considerable research and experimental work has brought out new and various elements which offer problematical hazards, and each one is observed and studied in detail. Among the chief hazards is static electricity. In our ordnance plants every conceivable means to carry off accumulated static electricity has been provided—all machinery within the powder lines has been tested with ohmeters, and tags have been attached to be sure no grounding band has been removed. It is impossible to prevent the generation of static, but its accumulation is hazardous if allowed around high explosives for there is a possibility of its igniting bodies of powder—to say nothing of sensitive powder particles in the form of dust.

All employees working on the loading lines are furnished conductive shoes to carry off body electricity. Clothing which will not generate static is also furnished to men and women. Forbidden articles on any loading line include watches, chains, keys, knives, jewelry, fountain pens, mechanical pencils, combs, etc.

Extreme care is being taken to increase housekeeping methods where high-explosive powder is exposed. Dust accumulation is dangerous and must be controlled. Walls, ceilings, machinery, floors, crevices, and powder flues and containers are kept spotlessly clean. The purpose is to prevent shock, friction, static, or heat from causing any ignition. Moreover, keeping dust down is also essential from a health standpoint.

Safety inspectors are trained for five weeks. Part of this time is spent in class and the remainder on construction and on production lines. Their schooling covers 172 subjects. On loading lines that are active, these men report by phone to the safety office every hour, and their records are made every two hours. This method facilitates close observation throughout a shift. It is their duty to be sure every rule and regulation is obeyed in accordance with the Ordnance safety manual.—*E. W. Boden.*

VITAL OPERATIONS

Among today's most vital operations are the construction of powder and shell-loading plants, airports, military highways, barracks and cantonments. And—today's most reliable tractor, **Cletrac,** will be found on the most important of these vital jobs. **Cletracs** are built in sizes from 14 to 96 H.P. on the drawbar, gasoline and diesel.

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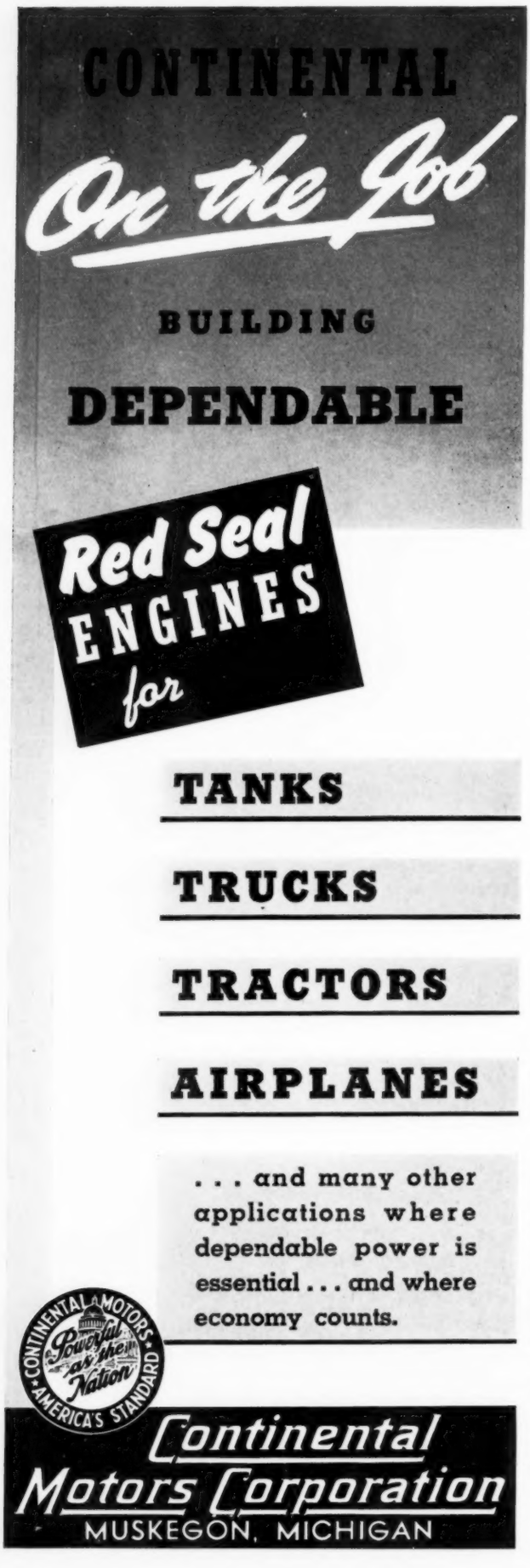


Defense Library

Timely Books

THE following books have been added recently to the library of the Army War College, Washington, D. C. They constitute a timely list of texts on various aspects of national defense. Army Ordnance *acknowledges with thanks the permission of Lieut. Col. R. B. Hough, Jr., librarian, to publish the list.*

Adams, John Clinton.—*Flight in winter.* Princeton: Princeton University Press, 1942. In view of the guerrilla warfare that the Serbs are now carrying on so successfully, this book, which tells the heroic story of the Serbian retreat in 1915, is particularly timely.

Azoy, Anastasio Carlos Mariano.—*The Army officer's manual.* New York: Appleton-Century, 1942. Handy manual for the use of both new and experienced officers.

Baldwin, Hanson W.—*What the citizen should know about the Navy.* New York: Norton, 1941. A handbook of what every civilian wants to know about the forces afloat.

Baumer, William.—*Not all warriors.* New York: Smith & Durrell, 1941. The author has selected seven illustrious sons of nineteenth-century West Point who made their mark in other than military pursuits and has given short biographies of these men.

Beith, John Hay.—*The battle of Flanders, 1940.* London: His Majesty's Stationery Office, 1941. Describes the experiences of the B.E.F. from the time of their landing in France in September 1939, to the final evacuation of Dunkerque on June 3, 1940.

Bond, Paul Stanley.—*Military science and tactics.* Washington: P. S. Bond, 1941. A manual for the Reserve Officers' Training Corps.

Bond, Paul Stanley.—*Military science and tactics—coast and antiaircraft artillery, basic course.* Washington: P. S. Bond, 1941. A text and reference of basic coast-artillery training, conforming to the War Department program.

Bond, Paul Stanley.—*Military science and tactics—engineers, basic course.* Washington: P. S. Bond, 1941. A text and reference of basic engineer training, conforming to the War Department program.

Brower, David R.—*Manual of ski mountaineering.* Berkeley: University of California Press, 1942. Explains the technique and equipment of ski mountaineering.

Brown, George William.—*The economic history of Liberia.* Washington: Associated Publishers, 1941. A well-documented study of the country, chiefly from the economic standpoint, and of its relations with Europe.

Colby, Elbridge.—*Army talk, a familiar dictionary of soldier speech.* Princeton: Princeton University Press, 1942. The author is a language scholar as well as an Army officer and has produced a dictionary of army parlance—both slang and official—arranged alphabetically, and containing the new terms that have come in since 1940.

Corbett, Percy Ellwood.—*Postwar worlds.* New York: Institute of Pacific Relations, 1942. Brings together the thought of active scholars and statesmen on the very urgent question, "What kind of a world will we be living in after the war?"

De Roussy De Sales, Raoul Jean Jacques François.—*The making of tomorrow.* New York: Reynal & Hitchcock, 1942. Concerning the American way of life and its destiny in the era to come.

Driggs, Howard Roscoe.—*Westward America.* New York: Putnam, 1942. Historical sketches and true stories of those famous old western trails—the Santa Fe, the Oregon, the Mormon, etc.—and of the men who blazed them and contributed to the westward march of America.

Emerson, Rupert.—*Government and nationalism in southeast Asia.* New York: Institute of Pacific Relations, 1942. Discusses the administration and nationalist movements in Malaya, Netherlands Indies, Burma, Thailand, Indo-China, Formosa and the Philippines.

Farago, Ladislas.—*The Axis grand strategy—blueprints for the total war.* New York: Farrar & Rinehart, 1942. Reveals the military and political plans of the Axis in the words of its own generals and admirals.

Fergusson, Erna.—*Our Hawaii.* New York: Knopf, 1942. Describes the evolution of a culture pattern unique in the world, and the people who share in it.

Fleisher, Wilfrid.—*Our enemy Japan.* Garden City: Doubleday, Doran, 1942. Gives the background of our war with Japan.

Gillespie, Robert Dick.—*Psychological effects of war on citizen and soldier.* New York: Norton, 1942. Main purpose of this book is to gather the lessons of experience from those who have endured the ordeals of modern war so that we may know what we have to meet and how to meet it.

Hauser, Heinrich.—*Time was—death of a Junker.* New York: Reynal & Hitchcock, 1942. Life story of a man who has known three Germanys—each the destroyer of the others.

Hinton, Harold Boaz.—*Cordell Hull.* Garden City: Doubleday, Doran, 1942. Biography of a man who is one of the most ardent champions of democracy and one of the foremost statesmen in the world today.

Institute of Pacific Relations.—*Industrial Japan.* New York: Institute of Pacific Relations, 1941. Aspects of recent economic changes as viewed by Japanese writers.

Lauterbach, Albert T. (*et al.*).—*Modern war—its economic and social aspect.* Princeton: Institute for Advanced Study, 1942. A tentative list of books and articles dealing with the economic and social aspects of modern war.

MacCormac, John.—*America and world mastery.* New York: Duell, Sloan & Pearce, 1942. Deals with the problems to be faced in establishing peace and economic reconstruction.

Mallory, Walter H.—Political handbook of the world, 1942. New York: Harper, 1942. A handbook of parliaments, parties, and press as of January 1, 1942.

Mencken, Henry Louis.—*A new dictionary of quotations on historical principles from ancient and modern sources.* New York: Knopf, 1942. Planned on strictly historical principles, with every possible quotation dated.

Mercer, F. A.—*Modern publicity in war.* London and New York: Studio Publications, 1941. A profusely illustrated study of British governmental and commercial propaganda under war conditions.

Newman, James R.—*The tools of war.* Garden City: Doubleday, Doran, 1942. A history of the tools of modern warfare, showing how the weapons of land, sea, and air developed.

"Old Sarge".—*How to get along in the Army.* New York: Appleton-Century, 1942. A guidebook for the Army volunteer or selectee.

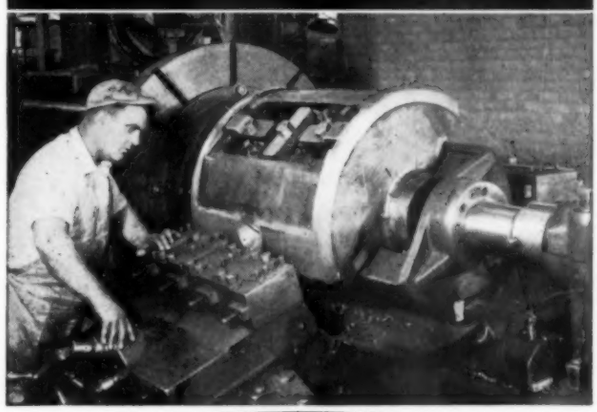
Raborg, Paul C.—*Mechanized might—the story of mechanized warfare.* New York: McGraw-Hill, 1942. Describes basic elements of strategy as used in modern warfare. Emphasis is on tank warfare, with detailed account of the motorization of the U. S. Army. Use of tank in the Balkan campaign and the Battle of France fully described.

Saint-Exupéry, Antoine de.—*Flight to Arras.* New York: Reynal & Hitchcock, 1942. Author describes an event of the last tragic days of France—a reconnaissance flight which he carried out over burning Arras—and relates it to the whole war and his philosophy of man.

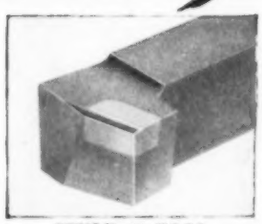
Saville-Sneath, R. A.—*Aircraft recognition.* Montreal: Penguin Books, 1941. Tells how to identify British and German airplanes.

Schriftgiesser, Karl.—*The amazing Roosevelt family, 1613-1942.* New York: Funk, 1942. Into this fascinating story of an amazing family there is also woven the history of a nation.

Interrupted Cuts — WON'T INTERRUPT PRODUCTION



When KENNAMETAL is in the tool rest



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STYLE 11 TOOL

STYLE 19 TOOL

BECAUSE of its superior transverse-rupture strength (305,000 lbs. per sq. in.) KENNAMETAL can be used in making interrupted cuts without danger of tool breakage. The illustration shows four KENNAMETAL Style 11 tools machining a cast armor steel tank part on a 48" x 84" engine lathe. Turning speed is 165 surface ft./min. with a feed of 0.014" per rev. and a depth of cut ranging from ¼" to ½". Large 1" x 2" tool shanks are employed to provide adequate support for the KENNAMETAL tips, and the tools are staggered so that only one tool hits the work at a time.

If interrupted or jump cuts are causing excess tool breakage and consequent delays in your plant, investigate the superior strength, hardness and crater resistance of KENNAMETAL. Write for free copy of the new vest pocket manual for KENNAMETAL users. It explains in detail how to get the utmost in production from your KENNAMETAL tools.

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Armament Reference

A selected list of military armament references in current engineering and technical periodicals compiled in the Ordnance Library; S. H. Pendleton, librarian.

Alloys

Light alloys in modern warfare. Reviews the part played by light alloys in war production and gives table of world production of aluminum. P. M. Haenni. *Canadian Metals & Metallurgical Industries,* February 1942, p. 36.

Ammunition

Army constructs 119-mile railroad at ordnance plant. *Railway Age,* March 28, 1942, p. 638.

Automatic machine for painting small shells. *Metals and Alloys,* April 1942, p. 627.

Cleaning steel shells. Cleaning methods successfully utilized for 75-mm. to 155-mm. shells, including high-explosive, antiaircraft and howitzer types of ammunition. G. Russell Hersam. *Industrial Finishing,* March 1942.

Converted lathes machine high-explosive shell. Account of the conversion of an idle plant to production of shells. *American Machinist,* April 16, 1942, p. 335.

Federal shell inspection gages. Shell inspection gages of improved design for simultaneously checking any desired number of surfaces for size and concentricity. *Machinery,* April 1942, p. 224.

Hardness conversions relations for cartridge brass. J. R. Townsend. *A.S.T.M. Bulletin,* March 1942, p. 35.

Modern shell and hollow-forging production. Brief description of the Baldwin-Omes, Loewy hydraulic-press, Witter, and torpedo forging processes. *Machinery* (London), March 12, 1942, p. 184.

Producing smokeless powder by 1942 methods. R. E. Hardy. *Chemical & Metallurgical Engineering,* April 1942, p. 76.

Shell percussion primers can be manufactured with light equipment. *Iron Age,* April 2, 1942.

Simplex shell-centering machine. *Machinery,* January 1942, p. 165.

Steel cartridge cases. *Coast Artillery Journal,* March-April 1942, p. 63.

Ammunition—Bombs

Bombs for low-level attack. W. E. Hick. *Aëronautics,* April 1942, p. 20.

Casting the eggs of war. Illustrations and brief description of the processes of casting the casings for bombs. *Popular Science,* April 1942, p. 102.

Growth of fire power in navy planes. J. B. Hancock and E. Burton. *Aëro Digest,* February 1942, p. 70.

Ammunition—Small Arms

Coördination of small-arms ammunition tool designs. E. P. Huchzermeier. *Tool and Die Journal,* March 1942, p. 28.

Artillery

Floor waxers to gun parts—plant conversion. *Steel,* March 16, 1942, p. 30.

New plants of 1941; gun mounts and carriages. *Factory Management,* April 1942, p. B65.

Aircraft attack on tanks, with special reference to the Russo-German war. Attacking from the rear at low level, Germans claim to have destroyed a number of Russian medium tanks by using 20-mm. aircraft cannon. *Royal Aëronautical Society Journal,* February 1942, p. 49.

What's new in guns. A simplified explanation of the function and advantages of various types of machine guns and light ord-

nance used as aircraft armament, indicating the manner in which they are selected and the influence of increased fire power on the design of fighter aircraft. James L. H. Peck. *Air Trails,* April 1942, p. 10.

Antiaircraft guns for merchant vessels. Description of operations in the quantity manufacture of antiaircraft guns for merchant vessels. *Machinery* (London), March 19, 1942, p. 205.

Equipment builder converts plant to manufacture of guns. *Steel,* March 23, 1942, p. 26.

Machining 37-mm. gun barrels. *Iron Age,* March 19, 1942, p. 42.

Automotive

American tank production. *Engineer,* January 30, 1942, p. 102.

Bigger tanks. *American Gas Association Monthly,* February 1942, p. 58.

Heat treating cast tank hulls. *Iron Age,* January 8, 1942, p. 39.

Mechanized warfare. L. Martland. *Automobile Engineer,* March 1942, p. 118.

Methods used in tank production. Production methods and details on manufacturing procedure by which sprocket wheels for driving caterpillar tracks are produced. *Machinery* (London), February 12, 1942, p. 103.

Radio in the armored force. J. M. Askew. *Radio News,* January 1942, p. 34.

Centrifugal Casting

Centrifugal steel casting. *American Machinist,* March 5, 1942, p. 202.

Explosions

Blast and its effects. *Commonwealth Engineer,* November 1, 1941, p. 101.

Forging

Properties of heavy forgings. Section VII in a series on forgings, forging methods and forging equipment. George Sachs. *Steel,* April 6, 1942, p. 76.

Honing

Principles of the honing process. *Machinery* (London), March 12, 1942, p. 175.

Impact

Effect of strain rate upon the tensile impact strength of some metals. E. R. Parker and C. Ferguson. American Society for Metals—*Transactions,* March 1942, p. 68.

Machine Guns

Compressed air helps clean machine-gun barrels. *Compressed Air Magazine,* April 1942, p. 6721.

Making the Bren breechblock. Description of more than 100 operations, including about 80 machining operations, necessary to produce the breechblock for the Bren machine gun as manufactured in the Canadian plant now in production on this weapon. *American Machinist,* April 2, 1942, p. 290.

Machine Tools and Machinery

Machines for victory. Examples of machines are presented with classification, description, and definition of each machine. *Tool Engineer,* March 1942, p. 83.

Rubber, Synthetic

Butadiene is real bottleneck in synthetic-rubber progress. Production trends in war materials such as airplane fuels, toluene, and raw materials for synthetic rubber, foreign production, butane needs, butadiene from coal. *Oil and Gas Journal,* March 26, 1942, p. 128.

Elastomers in nation's war program. Review of natural and synthetic elastomers in accordance with physical and chemical properties; outline of uses to which they are put in nation's war effort. W. C. Geer. *Chemical Industries,* January 1942, p. 22.

Synthetics or rubber. Present status with reference to synthetic-rubber situation; facts show only military needs may be taken care of. *Canadian Automotive Trade,* February 1942, p. 30.

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Book Reviews

AMERICA'S STRATEGY IN WORLD POLITICS—THE UNITED STATES AND THE BALANCE OF POWER. By Nicholas John Spykman. New York: Harcourt, Brace, & Company. $3.75.

THE inception and development of geopolitics is generally accredited to Germany, and it is certainly true that ever since the turn of the century Germany's military scholars have brought it closer and closer to an exact science. Probably the best approach to its study by one unfamiliar with its intricacies is to realize that it is composed of our old friends of school days—geography, history, and political science—fused and wrought to the uses of modern military art. Indeed, it would seem that to give it an explanatory name, such as "science of political warfare," would do much to bring our people to an understanding of this vital aid to modern war. Understand they must, and quickly, for Germany and Japan have gotten a far greater start in this study than in even physical preparation.

Professor Spykman has done a competent piece of work in this quite comprehensive volume of 500 pages. It is, of course, neither the first nor the last word to be written upon geopolitics in this country, but it would appear to be the best attempt to date to present a sweeping and understandable introduction of this immense subject to the American public. The author's approach to the military phase seems sound, though it is certain that closer collaboration with military and naval leaders, as in Germany, would add materially to the value of the work.

America's relations—political, economic, social, and military—with this hemisphere and with the powers of Europe and Asia are presented in detail, with the aid of a number of well-selected tables and maps. Throughout the book, Spykman is a realist. While never unprogressive, he yet rejects the visionary. Thus he is not blinded by such Utopian schemes as "Union Now," world federation, etc. And he admirably nails the fallacies of nineteenth-century liberalism, which did so much to ruin the victory of the Allies in 1918 and after, and which still crop up to plague America and Britain. F. W. F. G.

THE COMING SHOWDOWN. By Carl Dreher. Boston: Little, Brown & Company. $3.

THE publishers announce this as a challenging book—one that "invites attack." But after wading through its tightly packed pages of almost sarcastic condemnation of everything, this reviewer feels about as much like attacking it as he would to get up on the soap box and attack the tirades of a social reformer in the roped-off sections of Columbus Circle or Hyde Park. The book follows the pattern of scores like it that appeared during the depression—300 pages of attempted proof that everything so far tried is wrong, and a final chapter on the author's foolproof system for the perfect-working society.

Too much space is given to rehashing bygone faults of business organizations and dwelling on governmental mistakes dating back as far as the last war. Mistakes of the present war in underestimating copper, aluminum, and steel requirements are treated as if they were the machinations of deliberate intent. The author ignores the fact that in a society of 132,000,000 people the struggle upward can be only by trial and error, and that the resistance offered by "vested interests" is necessary to maintain a balance and to prevent a rushing into untried changes that could often lead to hopeless chaos.

Having observed in closest detail the entire N.R.A. experiment and its aftermath, this reviewer feels that the author of this book has not profited by the experiences since 1933. All in all, the book is a rehash of selected errors made in our social life,

a blending in of many of the exploded theories of Technocracy, and a final paper design for a perfect industrial-labor corporate state that would work in practice only if we all lost our individualities and had perfect men guiding the machine. G. S. B.

WHAT THE CITIZEN SHOULD KNOW ABOUT—ARMY ENGINEERS, MODERN WAR, CIVILIAN DEFENSE, AIR FORCES. New York: W. W. Norton & Company. $2.50 each.

THESE are some of a series of books "in language that we understand" on various phases of our war effort—defense and offense. Each one of this series is written by an authority on the particular subject treated therein; each contains pertinent illustrations.

"What the Citizen Should Know About Civilian Defense" is the result of collaboration between Walter D. Binger, chairman of the National Technological Civil Protection Committee, and Hilton H. Railey, now a special writer on civilian-defense matters for the *New York Times*. The volume deals with the civil problems that have been known to arise and are apt to arise from enemy air action. Protection—physical and psychological—against the various types of bombs, as well as camouflage, blackout, and protective concealment all are dealt with. The experience of the British civil population is here also brought to bear on our own problems.

"What the Citizen Should Know About Modern War" is almost an encyclopædic handbook of information designed to familiarize the citizen with terms and methods of modern combat in order to facilitate his understanding and evaluation of war news. Fletcher Pratt, who has been writing on military and naval affairs for twenty years, has here given us not just a dictionary of war words, but rather he outlines for us what we fight with, how to recognize it, and how it is employed in war as waged today.

"What the Citizen Should Know About the Army Engineers," by Lieut. Col. Paul W. Thompson, tells of the U. S. Corps of Engineers from General Washington to the present and specifically of the Corps in the present war. It is the story of the engineer at the front and behind the lines, building and destroying obstacles, maintaining routes of communication and utilities, providing maps and camouflage. It is also the story of the engineer in peace—constructing works for the improvement of our rivers and harbors and otherwise contributing to the peace-time pursuits of the nation.

"What the Citizen Should Know About the Air Forces" outlines and describes for the U. S. citizen the organization of the Army, Navy, and Marine Air Forces and that of the Coast Guard which is now incorporated within the Navy air arm. It contains frequent illustrations of insignia and planes of the various types, charts of bombs and diagrams of the organizational set-up. The personnel involved in the maintenance and flight of each type of aircraft are described in brief detail as well as every phase of aviation. Gunnery, bombing, photography, navigation, radio, and meteorology are some of these. In all, this volume by Lieut. Col. Harold E. Hartney is as composite and informative a work as the citizen could desire. J. C. D.

VICTORY IN THE PACIFIC. By Alexander Kiralfy. New York: John Day Company. $2.75.

WHETHER the reader of this book agrees with all the points or not, he must agree that the author has a wide knowledge of his subject and his given it infinite thought. There is too much detail to make it a popular layman's book, but it can be read with profit by any one directly concerned with the tactics of the present military and naval effort.

The author has tried to diagnose the Japanese military mind, and the movements of the Japanese since the book was written would indicate that he has done this with some success. The mistakes of American naval tactics at the outset he rightly at-

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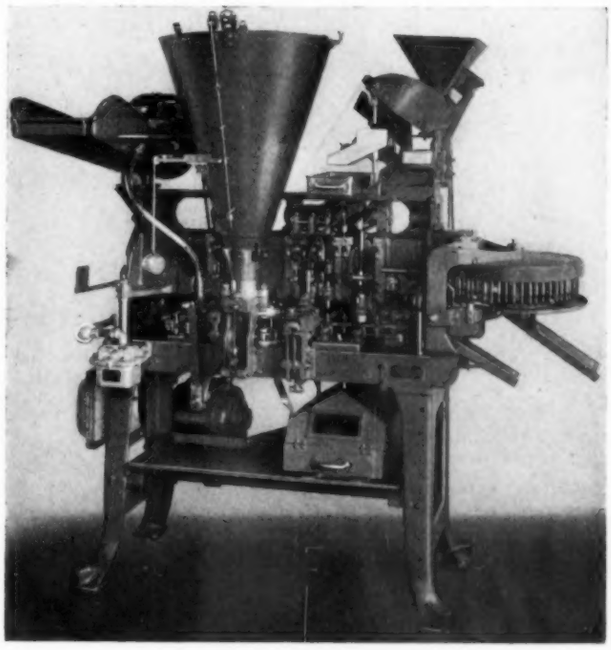

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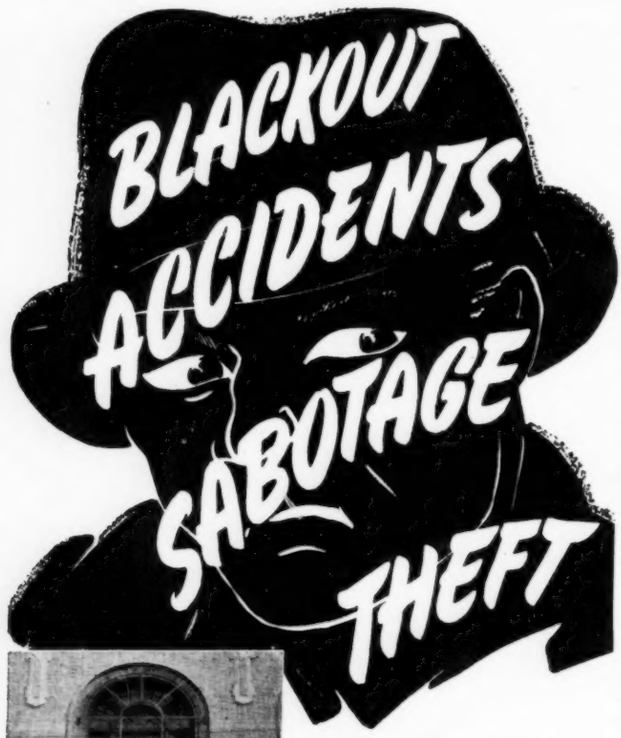
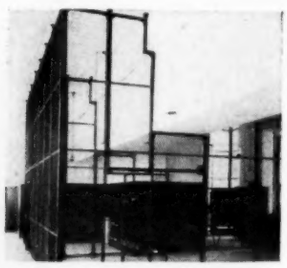


WINDOW GUARDS—*a "must" in most munitions plants. May be installed outside, or inside.*



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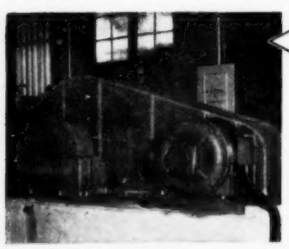

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tributes to lack of foresight and realistic thinking on the part of the democratic peoples themselves. To watch possible hostile movements emanating from the Japanese-mandated islands prior to the actual outbreak of hostilities would have required a vast number of planes—and the exhaustion of crews and the depreciation of long-range warplanes would have been criticized by the very men who, after Pearl Harbor, criticized the lack of watchfulness. Mr. Kiralfy believes that any of the 700 days before December 7, 1941, would have been a logical day for a Japanese raid. He does not, however, justify the lack of alertness in view of known facts about Japan's intentions.

In the opinion of the author, Japan has been counting more upon the inefficiency of its democratic enemies than upon its own efficiency. By creeping along the coasts and establishing land bases and short sea connections, she early destroyed the belief that she could be blockaded easily. Mr. Kiralfy believes that the real strength of the mandated islands lay in the mystery and bluff they were able to cast until Japan secured her foothold to the south and in Asia. He believes that they would have crumbled before early direct attacks, but that Japan did not expect such attacks to be made.

Better possibilities for victory are to be sought in the northern sectors of the Japanese triangle, the author thinks. The Japanese can stand defeats and withdrawals in far-off India or Luzon, but cannot withstand hammering from the north without loss of prestige and morale and without drawing in the lines now pushing outward. In other words, driving back the Japanese forward lines might be a long-drawn out work of attrition, with only slight injury to the main body, while blows at the body itself might cause such weakening as to wrest away the present advantageous initiative and force withdrawals. G. S. B.

An Atlas of Far Eastern Politics. By G. F. Hudson, Marthe Rajchman and G. E. Taylor. New York: The John Day Company. $2.50.

THIS very attractive and timely volume is issued under the auspices of the Institute of Pacific Relations. The text and the maps are the joint work of three competent scholars. Mr. Hudson, a leading English expert on Far Eastern affairs, wrote the text of the original British edition; Mr. Taylor, professor of history at the University of Washington, has added three new chapters covering the eventful years of 1938-1942, and Marthe Rajchman, an expert on the geography of the Orient and the author of "A New Atlas of China," drew the maps both for the original edition and the new chapters.

Text and maps together produce a clear and valuable account of a portion of the world about which exact information is so essential. This volume is an analysis of the geography, resources, and population of the Far East, the history of China, Japan, Siberia and Southern Asia, the results of the impact of the Westerners, and an interpretation of the meaning of Japan's thrust for empire. It is essential for an adequate understanding of the background of the present war in the Far East. L. A. C.

Army Flyer. By Lieut. Gen. H. H. Arnold and Brig. Gen. Ira C. Eaker. New York: Harper & Brothers. $2.50.

WITH a total of fifty-four years of Army aviation experience to back them up, Generals Arnold and Eaker have written this book to acquaint that vast group of new flying men now being trained for the Army Air Forces with the duties, responsibilities, opportunities, and advantages of their new profession, in the belief and hope that it may promote the safety and efficiency of America's air fighters. From flying cadet to general, it traces the career of the Army airman, suggesting reasons for choosing one branch or another and, once the choice has been made, what is to be expected of the individual and his group. "It is not for the *literati;* it is not for the feminine trade. It is for the Army's new flying men." D. C. J.